SEPTEMBER 1959

Radio-Electronics

HUGO GERNSBACK, Editor

35c

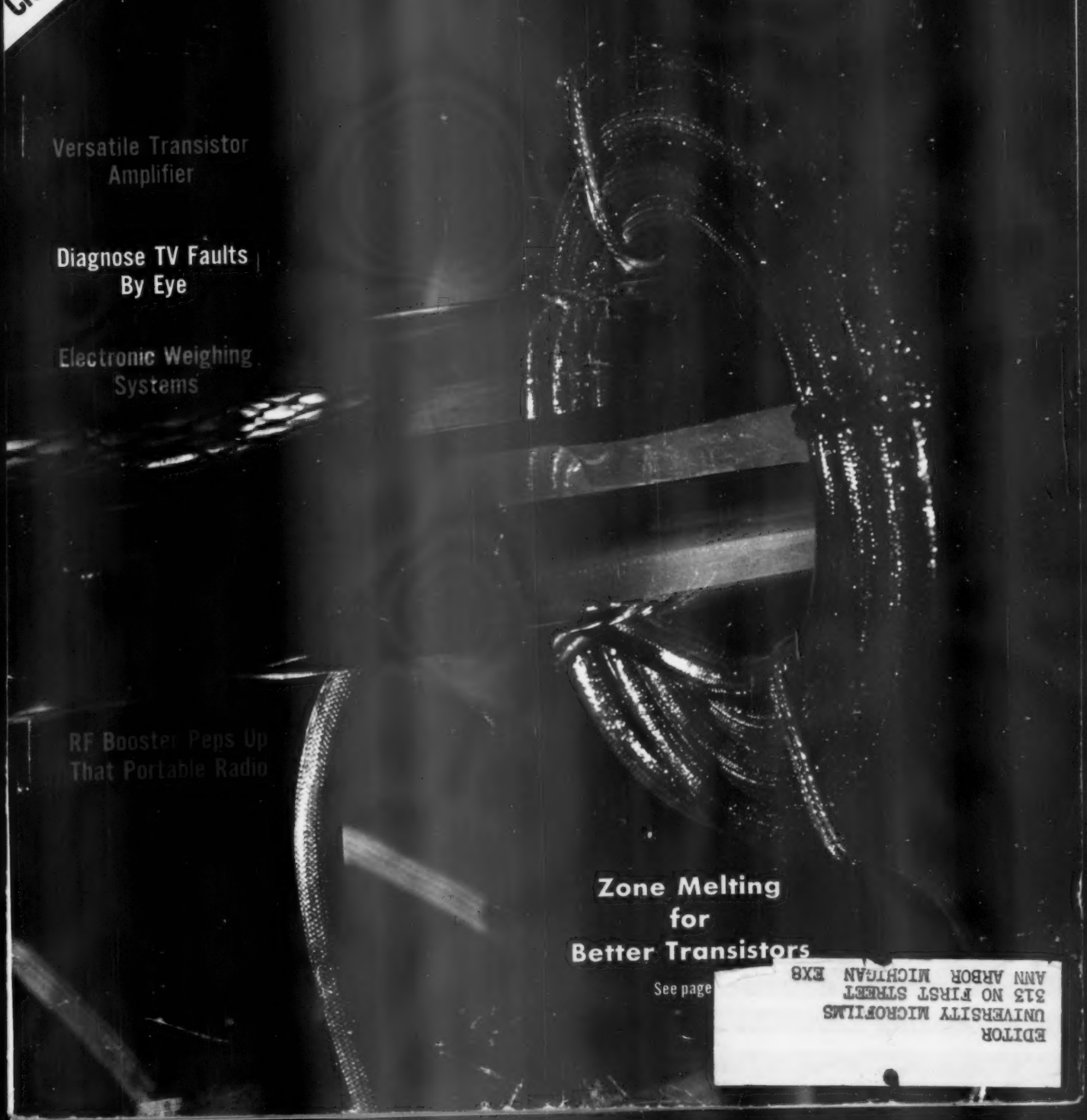
Citizen's Band Radios—how they work

Versatile Transistor Amplifier

Diagnose TV Faults By Eye

Electronic Weighing Systems

RF Booster Peps Up That Portable Radio



Zone Melting for Better Transistors

See page

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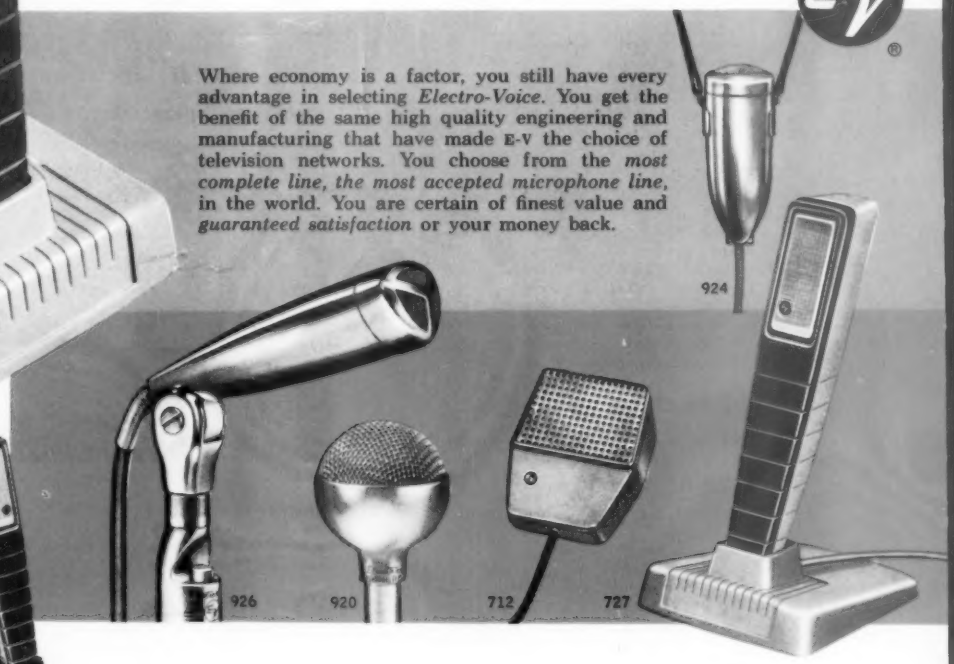

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ON THE COVER

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An ingot of germanium in a graphite boat is moving through the radio-frequency coil that melts a portion of it. The heated portions of the ingot on each side of the melted zone can be traced in outline.

Color original by Larry Ankersen, Sylvania Research Laboratories

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NEWS BRIEFS

DR. RUSSELL H. VARIAN, who with his brother Sigurd invented the klystron, died July 28, at the age of 61, following a heart attack which felled him while aboard the cruise ship Northwind, west of Juneau. Besides the klystron, a device vital to radar important in parametric amplifiers, Dr. Varian held more than a hundred patents in the fields of Microwave electronics and applied physics. He was chairman of the board of Varian Associates, a California electronics firm he helped found 11 years ago.

NEW DEVICE for switching or modulating high wattage ac with small direct currents is the *Ovitron*, a recently developed electrochemical cell. It's simple—two load-connected electrodes and a grid control element immersed in an electrolyte, permanently sealed in a small container. It is made by Ovitron Corp., Detroit, Mich.

The electrodes are normally coated with a nonconducting oxide film. Voltage applied to the control element polarizes the electrodes at once, making the oxide film conductive by forcing metal ions into it. Current can then flow freely between the electrodes.

Typical unit being shown in the photo by C. R. Allen has power gain up to 28 db and controls up to 770 ma with only 32 ma. Internal resistance is about 2 ohms. Printed specs so far refer to operation at 60 cycles, but the device has been operated at 1,000 cycles with little difference. Units have already been built for handling up to 15 amperes. The diagram shows an Ovitron in the on condition with dc control excitation obtained from the load current with two small diodes. A variable resistor substituted for the switch at upper left allows continuous modulation of the load current.

TUNNEL DIODE promises large amounts of amplification at frequencies that may run up to 10,000 mc. Power required may be less than 1% of that required by a transistor.

First described by the Japanese scientist Esaki in 1958, the tunnel diode, according to RCA and G-E scientists, is a p-n junction composed of materials more heavily doped with impurities than conventional diodes and so made that the barrier layer between p and n sections is very thin. A low forward bias is placed across the diode. As this bias is increased, the current increases more rapidly than standard diode theory would predict. Electrons that would not normally have enough energy to get "over" the barrier are said to "tunnel" through it. As the bias is increased still further this tunneling effect drops off and the diode begins to act more like a conventional type. This causes an actual *decrease* of current as the voltage is being increased. Raising the voltage still more causes the current to rise again in a normal manner.

Because of the negative resistance portion of the voltage current curve, the diode can be used as amplifier or oscillator.

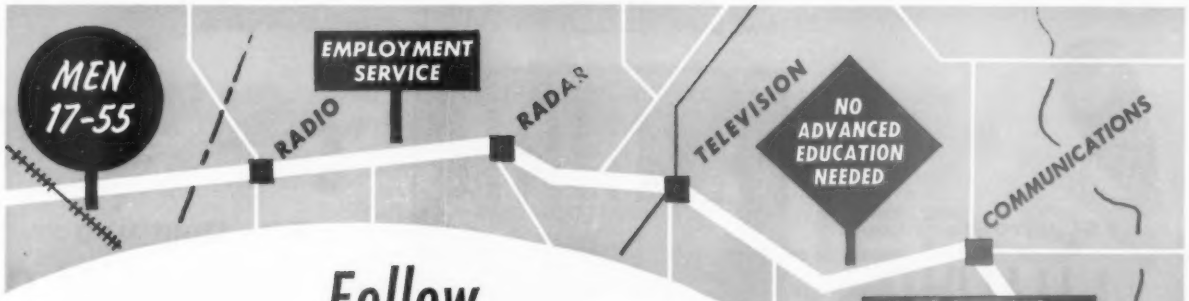
In a press preview given by General Electric Co. in New York an FM receiver using only a single tunnel diode plus an ordinary diode detector was demonstrated. Output was sufficient to operate an audio amplifier in a normal manner. Also displayed were an oscillator that held frequency while being alternately put in an oven and a tube of liquid nitrogen.

A gain of 30 db at one-mc bandwidth was obtained in the 100-mc region and, up to 80-db gain has been gained in special narrow-band systems.

Still in the developmental stage and possibly a number of years from practical application, the tunnel diode may have important applications wherever light weight and independence from environment, low noise at high frequencies or fast action is important. Examples are satellites or portable and citizens radio; many types of uhf communication and even uhf TV; control and switching, where the tunnel diode can act 100 times faster than a transistor.

"LAUNDROMAT" approach to the paperwork problems of the small business man is promised by RCA's data processing centers, first of which was opened at Cherry Hill, N. J., recently. Built around RCA's 501 computer, the centers will be open to businesses not large enough to justify ownership of a data-processing system. In some cases, a week's work may be brought in and run through in part of a morning. In others, the volume of business may justify installing some equipment in the customer's office. In medium-sized businesses, this would be sufficient simply to transmit information to the processing center; the results would be returned to the customer in paper form. In even larger establishments, complete input and output circuits might be maintained in the customer's office—thus work could be done almost as fast as if the business owned a data processor.

BIRD OF TIME is the name given by Hughes Aircraft engineers to their latest project, a clock in a satellite, to be used to check Einstein's theory that a clock traveling at great speeds would apparently run slower than one on the earth. Such a clock would have to be extremely accurate, if any dif-



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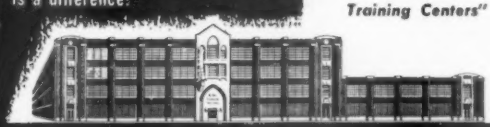

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Dr. Harold Lyons, in charge of "Bird of Time" project and atomic clock's inventor, shows how in a satellite it could check the theory of relativity.

ference were to be noted at speeds attainable by present satellites. A special master clock weighing only 30 pounds is under construction for the purpose. Its error is estimated as less than a second in 1,000 years.

The theory that time moves more slowly at speeds approaching that of light is one of the most intriguing facets of the relativity theory. It is a favorite theme of science-fiction stories in which, for example, the hero bids farewell to his 20-year-old sweetheart at the spaceport, returning "a year" later to find her 20-year-old great-granddaughter. At the 18,000-mile-per-hour speed of the satellite, however, the expected difference in time between the moving and earthbound clocks would be only about 1/60 second a year.

Besides checking the theory of relativity, the atomic clock would be useful in measurements of the shape of the earth, in checking whether space is the same in all directions, and in measuring the velocity of light or radio waves.

THERMO-ELECTRIC AIR CONDITIONER for submarines will use the Peltier effect in which current passing through the junction of two dissimilar materials in the right direction takes heat away—it cools. RCA Labs has already demonstrated solid-state materials in an electronic refrigerator and to cool a small room. Now they'll work out the details for a Navy sub, using this principle discovered by a French physicist over 100 years ago.

Building blocks of the devices, which contain no moving parts, can theoretically be combined for almost any capacity of cooling. The limiting factor appears to be the heat exchange, or means of getting rid of the heat which

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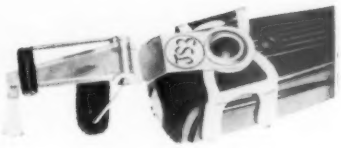

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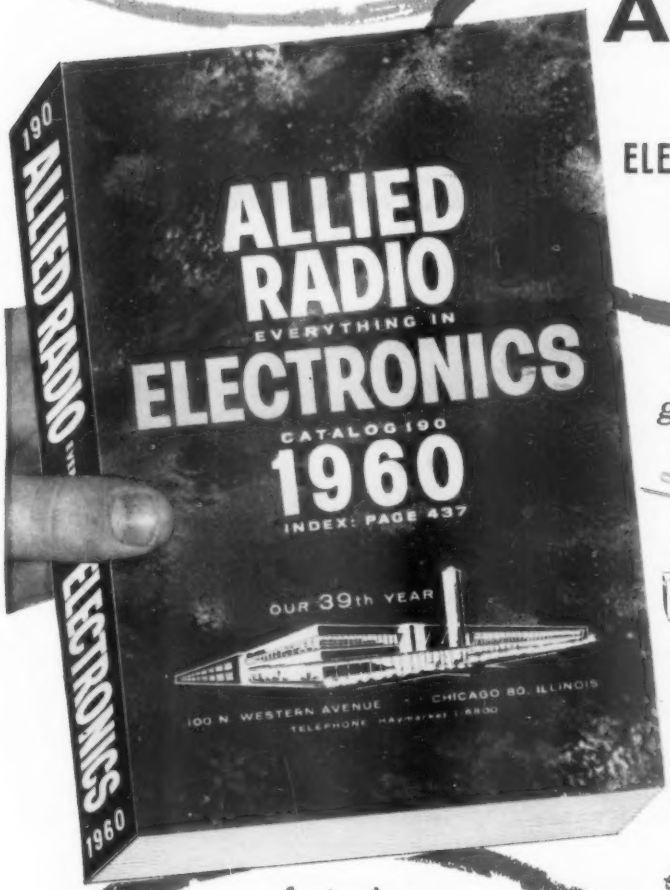

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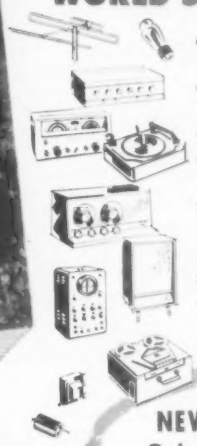

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the thermo-electric materials absorb from the air which is cooled. In ships, this may not be a serious problem, since unlimited cooling water is available. Materials developed thus far promise quietness, compactness, ruggedness, little maintenance and long life, as contrasted with the relatively complex air conditioners of today.

FOUR NEW TV stations are operating in the US:

KTLE, Pocatello, Idaho..... 6
WENH-TV, Durham, N. H.....11
KHTV, Portland, Ore.....27
WXIX, Milwaukee, Wis.....18

WENH-TV is educational, and WXIX has been revived after a 4-month absence from the air. The US operating station total jumps to 558, including 469 vhf and 89 uhf. The noncommercial figure is upped to 42.

Canada has added 2 more stations to its roster, making a total of 56.

CBVT, Corner, Nfld..... 3
CHAB-TV, Moose Jaw, Sask..... 4

CBVT is a satellite of CBHT, Halifax, N. S., channel 3.

Calendar of Events—Aug.–Sept.

British Radio Show, Aug. 26–Sept. 5, Earls Court, London, England.

Association for Computing Machinery Conference, Sept. 1–3, MIT, Cambridge, Mass.

National Exhibition of Radio, Television and Records, Sept. 10–21, Exhibition Park, Porte de Versailles, Paris, France.

High-Fidelity Music Show, Sept. 11–13, Hotel Pfister, Milwaukee, Wis.

Heart of America Rep Conference, Sept. 12–13, Excelsior Springs, Mo.

Engineering, Writing & Speech Symposium, Sept. 17–18, Sheraton-Plaza Hotel, Boston, and Ambassador Hotel, Los Angeles.

High-Fidelity Show, Sept. 18–20, Palmer House, Chicago, Ill. (RADIO-ELECTRONICS will exhibit in Room 746)

Instrument Society of America, Instrument-Automation Conference & Exhibit, Sept. 21–25, Palmer House and Morrison Hotel. Exhibit at International Amphitheatre, Chicago, Ill.

EIA Fall Conference, Sept. 22-24, Traymore Hotel, Atlantic City, N.J.

Conference on Nonlinear Magnetics and Magnetic Amplifiers, Sept. 23–25, Shoreham Hotel, Washington, D.C.

Broadcast Symposium, Sept. 25–26, Willard Hotel, Washington, D.C.

High-Fidelity Music Show, Sept. 25–27, Hotel Sheraton, Rochester, N.Y.

National Symposium on Space Electronics & Telemetering, Sept. 28–30, Civic Auditorium & Whitcomb Hotel, San Francisco, Calif.

Industrial Electronics Symposium, Sept. 30–Oct. 1, Mellon Institute, Pittsburgh, Pa.

GLASS MAKER'S CHARGES that half the people who buy rebuilt CRT's think they're getting all-new ones are based on a survey made for the Kimble Glass Co., an Owens-Illinois subsidiary. Their survey states that 79% of the families questioned believed they'd bought "new" picture tubes. But J. P. Kearney, president of Kimble, said that only 20% of the 6,000,000 replacement CRT's sold each year are actually *new glass.*

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Irving L. Laing,
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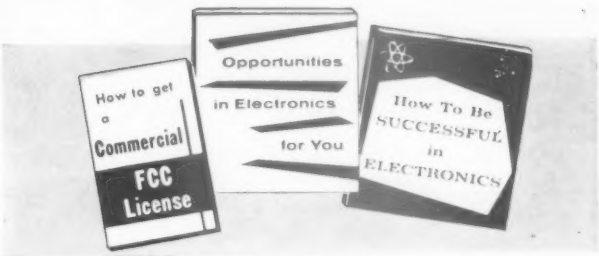

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Frequency response: 20 to 16,000 cps. • Tracking force: 5 grams.
Output: 0.5V, each channel • Channel separation: 20 DB

ERIE Electronics Distributor Division
ERIE RESISTOR CORPORATION
Erie, Pennsylvania

It is believed that consumers indicated some confusion as to what "rebuilt" meant when 59% said they would not buy a rebuilt tube. Industry authorities decried the misrepresentation some dealers are believed to have practiced in selling "rebuilts" at new tube prices. They pointed out though, that a reused *envelope* will deliver the same quality picture as a "new" CRT with brand-new glass. "It's like reusing a milk or Coke bottle," one pointed out to RADIO-ELECTRONICS.

Calendar of Events—October

Stereo and Hi-Fi Show, Oct. 2–4, Davenport Hotel, Spokane, Wash.

National Communications Symposium, Oct. 5–7, Hotel Utica, Utica, N.Y.

Motion Picture & Television Engineers Convention, Oct. 5–9, Statler-Hilton Hotel, New York.

Audio Engineering Society Convention and Equipment Exhibit, Oct. 5–9, Hotel New Yorker, New York, N.Y.

Institute of High Fidelity Manufacturers Hi-Fi Show, Oct. 5–10, New York Trade Show Building. (RADIO ELECTRONICS will exhibit in Room 525.)

EIA Value Engineering Symposium Oct. 6–7, University of Pennsylvania, Philadelphia, Pa.

Conference on Radio Interference Reduction, Oct. 6–8, Museum of Science & Industry, Chicago, Ill.

Canadian IRE Convention, Oct. 7–9, Exhibition Park, Toronto, Canada.

National Electronics Conference, Oct. 12–14, Hotel Sherman, Chicago, Ill.

Home Entertainment Show, Oct. 15–18, Rice Hotel, Houston, Tex.

Detroit High Fidelity Show, Oct. 16–18, Statler Hotel.

Portland (Ore.) Stereo & Hi-Fi Show, Oct. 16–18, Multnomah Hotel.

URSI Fall meeting, Oct. 19–21, El Cortez Hotel, Balboa Park, San Diego, Calif.

East Coast Conference for Aeronautical and Navigational Electronics, Oct. 26–28, Lord Baltimore Hotel, Baltimore, Md.

Michigan Industrial Electronics Exposition, Oct. 28–29, Detroit Artillery Armory, Oak Park, Mich.

Electron Devices Meeting, Oct. 29–30, Shoreham Hotel, Washington, D.C.

Buffalo (N.Y.) Hi-Fi Show, Oct. 30–Nov. 1, Statler Hotel.

ANTI-RADAR INVENTOR Dr. Otto Halpern has received $340,000 for his development of a method for absorbing high-frequency waves. The payment climaxed an 18-year fight with the Government. Dr. Halpern's method was used by the Navy in World War II. Later the Air Force adopted the invention, and used it on planes during the Korean war to scramble enemy radar.

Having received nothing for his idea during the hostilities, he tried to patent it after the war. The application was turned down on the grounds that it would endanger national security. Then he tried in vain to get a cash settlement from the Navy. Dr. Halpern initiated court action, at the same time continuing negotiations with the Government, with the result that the Navy made the cash settlement. He also received a warm letter of appreciation from the Defense Secretary. END

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25. Two very popular piano works

27. Granada, La Paloma, 11 more

10. Be My Love, Where or When, etc.

9. Always, Please, Speak Low, 9 more

11. Berlioz' most popular work

22. Organist Cole plays 11 hit tunes

3. Didn't It Rain, God Is Real, etc.

29. High-spirited, gay symphonies

20. Come to Me, Long Ago, 10 more

31. Solitude, Autumn Leaves, etc.

36. The ballet that "rocked the world"

28. Brahms' most beloved symphony

16. Two colorful, exciting scores

42. Body and Soul, I Got It Bad, 10 more

18. Two electrifying tone poems

33. 11 beautiful, immortal melodies

41. Strauss' loveliest tone poems

45. Tico-Tico, Brazil, 10 others

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★ The records you want are mailed and billed to you at the regular list price of $4.98 (Classical Selections, $5.98), plus a small mailing charge

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Stereo records must be played only on a stereo phonograph

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2	24
3	25
5	27
6	28
7	29
8	30
9	31
10	33
11	36
12	37
15	40
16	41
18	42
19	45
20	49
21	50

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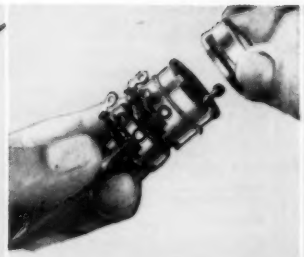

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Your distributor can custom-assemble any of over 38,000 combinations in just 30 seconds.
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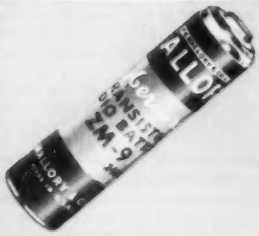

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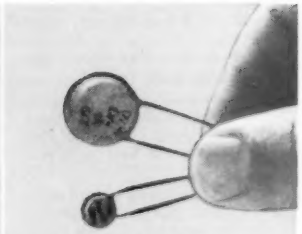

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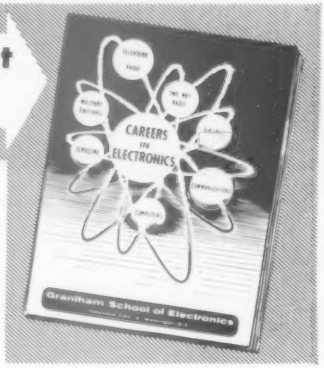

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Howard E. Martz, 301 S. Penn. St., Fairmount, Ind.	1st	24
John W. Dempsey, Box 55, Rising Sun, Md.	1st	12
Donald H. Ford, Hyannis RD, Barnstable, Mass.	1st	12
Richard J. Falk, 2303 Holman St., Bremerton, Wash.	1st	22
Denson D. McNully, 1117 N. Houston St., Amarillo, Texas	1st	9
James D. Hough, 400 S. Church St., East Troy, Wisc.	1st	12
Odie B. Perry, Jr., Rt. #3, Zebulon, N. C.	1st	12
Milton C. Gee, Rt. #1, Washington, N. J.	1st	11

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Seattle Division	408 Marion Street Seattle 4, Wash. (Phone: MA 2-7227)
Kansas City Division	3123 Gillham Road Kansas City 9, Mo. (Phone: JE 1-6320)
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I am interested in: ☐ Home Study, ☐ Resident Classes 94-P

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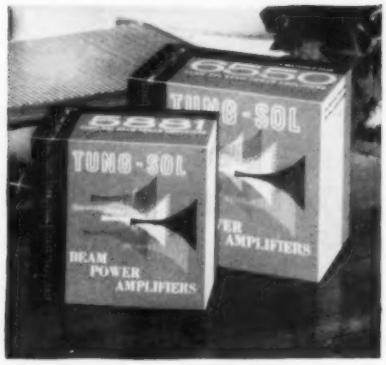

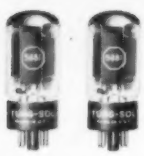

5881 For service in amplifiers of up to 50 watts.

6550 For service in amplifiers and commercial audio equipment of up to 100 watts.

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Use of Tung-Sol 5881 and 6550 tubes has long been associated with amplifiers of the very finest design. These tubes have always been produced to closest possible tolerances with cathode current ranges held to an absolute minimum.

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Tung-Sol Electric Inc., Newark 4, New Jersey.

TUNG-SOL®

Correspondence

RADIO ON THE MOON

Dear Editor:

I found your editorial "Radio On The Moon" particularly interesting and timely and would not in general contest your conclusions.

However, I must take exception to your statement relative to knife-edge diffraction, since it may be subject to misinterpretation.

The presence of an atmosphere is required for the scattering and refraction of radio energy, but not for the diffraction of radio energy. As for the relative merits of a communications signal relayed via the earth and a signal diffracted over a smooth surface or a knife edge, this is a function of geometry involved, the signal radio frequency and the composition and irregularity of the moon's surface. I would suspect that for many short paths a diffraction path would have the advantage, but in view of our ignorance of the surface conditions on the moon this is mere conjecture on my part.

You are correct, I believe, in feeling that the extreme large-scale irregularities of the moon and its smaller radius do give the advantage for communications between widely separated locations on the moon to signals relayed via the earth.

To summarize, the diffraction of radio waves will occur on the moon's surface, although an estimate of its usefulness for communications via radio would require that we make assumptions concerning the composition and small-scale topography of the moon. This does not however invalidate the general conclusions of your editorial.

H. T. DOUGHERTY
Central Radio Propagation Labs.
National Bureau of Standards
Boulder, Colo.

DANGEROUS FLUIDS

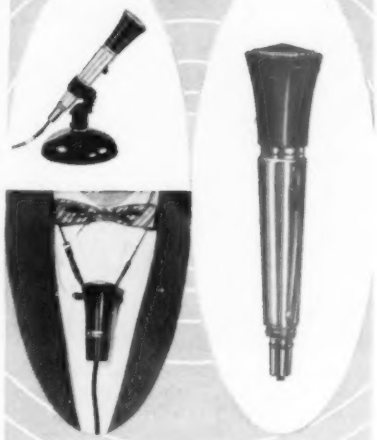
Dear Editor:

I'm sure that many of your readers appreciated the article "Ultrasonic Cleaning" in the June edition of RADIO-ELECTRONICS. . . .

Many solvents can be used as the cleaning agent with ultrasonic cleaners. The solvent mentioned in your article is probably safe. However, we in the electronics field have a tendency to use carbon tetrachloride for most cleaning jobs around the shop. This is where death is lurking in the shadows of the ultrasonic cleaner. When carbon tetrachloride is used in an ultrasonic cleaner, the high-frequency agitations decompose

FOR P. A. OR TAPE

unlimited versatility . . .
exceptional performance . . .
long service life . . .
nominal cost . . .



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controlled magnetic microphone by
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Striking, streamlined unit delivers fine voice and music reproduction in dozens of public address and home recording applications. Whether used indoors or out, in-the-hand, or on a desk or floor stand, you'll be impressed by its fine response, high output, ruggedness and beauty of design. The Commando offers you such important features as dual impedance, on-off switch, and cable connector. Patented controlled magnetic construction is unaffected by extremes of temperature and humidity, can be depended on to maintain high level of quality through tough, sustained usage, year after year.

the Commando is available in three models:

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A dual-impedance unit with A25 swivel adapter, on-off switch, cable connector
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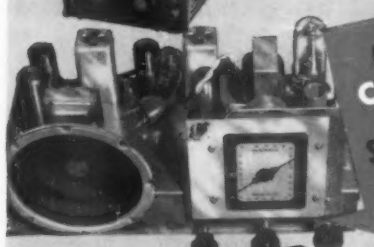

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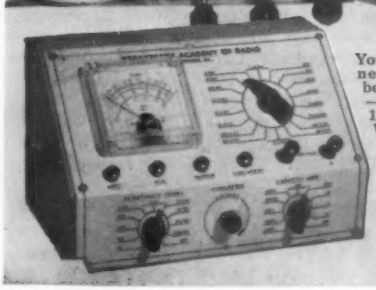

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Men by the thousands . . . trained Radio-Television Service Technicians . . . are needed at once! Perhaps you've thought about entering this interesting, top paying field, but lack of ready money held you back. Now—*just $6 enrolls you* for America's finest, most up to date home study training in Radio-Television! Unbelievable? No, the explanation is simple! We believe Radio-Television *must* have the additional men it needs as quickly as possible. We are willing to do our part by making Sprayberry Training available for less money down and on easier terms than ever before. This is your big opportunity to get the training you need . . . to step into a fine job or your own Radio-Television Service Business.

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Only a limited number of students may be accepted on this liberal and unusual basis. We urge you to act at once . . . mail the coupon below and get complete details plus our big new catalog and an actual sample lesson—*all free.* No obligation . . . no salesman will bother you.

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the cleaner into a deadly gas known as phosgene. This is the gas that caused so much damage to the lungs of soldiers during World War I.

The majority of manufacturers of ultrasonic cleaners mention this fact in their instruction manuals. However, there is always the chance that someone will flip the switch before reading the manual.

JACK DICKERSON
IBM Military Products Div.
Kingston, N. Y.

PLACE FOR PART-TIMERS?

Dear Editor:

One topic that occupies the spare time of many full-time radio and TV repairmen is the part-time service technician. Every service organization seems to be busy figuring out what to do about the part-timers. Most of the full-time men want to legislate them out of existence. But many of these full-timers started out themselves as part-timers, though they seem to have forgotten it today.

Of course, there are two kinds of part-time service technicians. One is the untrained or partially trained man. He may be a student, or someone who's had very slight training in the past, perhaps in the armed forces. The other is the technician, engineer or radio amateur who fixes equipment in his spare time. It is this group that I am writing about, for I don't believe that there in any place for the first group in our industry.

One of the second group who is typical is an engineer who started as a radio repairman in 1935. He worked as a civilian radio instructor for the Army and later as an electronic parts inspector during WW II. He was a part-time repairman and also worked as a transmitter operator in a local broadcast station. In 1945 he went to work as a junior engineer in a radio factory. Later he became a test-equipment designer and finally he worked in the factory as a development engineer. During all this time he kept on repairing radio and TV sets on the side. He lived in a town of about 1,000 people most of that time. He never competed with full-time service technicians because there weren't any in that town.

I'm sure that all across the country there are small towns where there is at least one part-time repairman. He may be an engineer who commutes to a nearby city, or perhaps he's a ham operator. In many cases school teachers or telegraph operators do part-time servicing. There is no need for these men to have a store, truck, or a license to fix sets. Of course they must comply with all legal restrictions, have a business license where required and pay all legal taxes. Residents in rural communities deserve good repair service and part-time technicians in small towns often perform valuable and difficult service. They should be encouraged to continue.

(*Continued on page* 22)

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by Practicing at Home in Spare Time

Without Extra Charge You Get

special NRI kits developed to give actual experience with Radio-TV equipment. You build, test, experiment with receiver or broadcasting circuits. All equipment yours to keep.

Have High Pay, Prestige, Good Future as a Skilled Radio-TV Electronic Technician

People *look up to* and depend on the Technician, more than ever before. Offices, plants, homes everywhere are obliged to buy his knowledge and services. His opportunities are great and are increasing. Become a Radio-TV Electronic Technician. At home, and in your spare time, *you* can learn to do this interesting, satisfying work—qualify for important pay. To ambitious men everywhere *here* in the fast growing Radio-TV Electronic field is rich promise of fascinating jobs, satisfaction and prestige as well as increasing personal prosperity.

Increasing Opportunities in Growing Field

A steady stream of new Electronic products is increasing the job and promotion opportunities for Radio-Television Electronic Technicians. Right now, a solid, proven field of opportunity for good pay is servicing the tens of millions of Television and Radio sets now in use. Color TV, Hi-Fi is growing. The hundreds of Radio and TV Stations on the air offer interesting jobs for Operators and Technicians.

More Money Soon—Make $10 to $15 a Week Extra Fixing Sets in Spare Time

NRI students find it easy and profitable to start fixing sets for friends and neighbors a few months after enrolling. Picking up $10, $15 and more a week gives substantial extra spending money. Many who start in spare time soon build full time Radio-Television sales and service businesses—enjoy security.

Act Now—See What NRI Can Do for You

NRI has devoted over 40 years to developing simplified practical training methods. You train at home in spare time. Get practical experience, learn-by-doing.

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Washington 16, D.C.

NRI Has Trained Thousands for Successful Careers in Radio-TV

Studio Engr., Station KATV
"I am now Studio Engineer at Television Station KATV. Before enrolling, I was held back by limitation of a sixth grade education." BILLY SANCHEZ, Pine Bluff, Ark.

Has All the Work He Can Do
"I have repaired more than 2,000 TV and Radio sets a year. NRI training certainly proved to be a good foundation." H. R. GORDON, Milledgeville, Georgia.

Has Good Part Time Business
"Early in my training I started servicing sets. Now have completely equipped shop. NRI is the backbone of my progress." E. A. BREDA, Tacoma, Washington.

SEE OTHER SIDE

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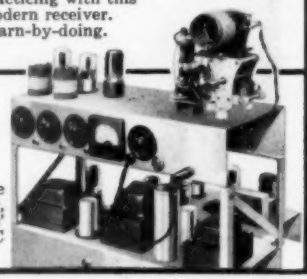

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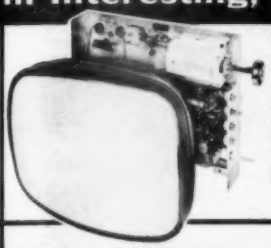

YOU BUILD This 17 Inch Television Receiver

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YOU BUILD Vacuum Tube Voltmeter

Use it to earn extra cash fixing neighbors' sets; bring to life theory you learn from NRI's easy-to-understand texts.

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4000 TV and Radio stations offer interesting positions. Govt. Radio, Aviation, Police, Two-Way Communications are growing fields. Trained Radio-TV Operators have a bright future.

J. E. Smith, Founder

Train at Home the NRI Way Famous for Over 40 Years

NRI is America's oldest and largest home study Radio-Television school. The more than 40 years' experience training men for success, the outstanding record and reputation of this school—benefits you in many ways. NRI methods are tested, proven. Successful graduates are everywhere, from coast to coast, in small towns and big cities. You train in your own home, keep your present job while learning. Many successful NRI men did not finish high school. Let us send you an actual lesson, judge for yourself how easy it is to learn.

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"I opened my own shop before receiving my diploma. I have had to hire extra help. I am independent in my own business." D. P. Cressey, Stockton, Cal.

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"NRI changed my whole life. If I had not taken the course, probably would still be a fireman, struggling along. Now Control Supervisor at WRCA-TV." J. F. Meline, NewYork, N.Y.

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SEE OTHER SIDE

Edwin Felch, project director in charge of developing the Titan guidance system, holds the "voice" of the ICBM.

VOICE OF A GUIDED MISSILE

This is a missile-borne transmitter. It is the "voice" of a missile in flight . . . part of a new radio-inertial guidance system developed by Bell Telephone Laboratories for the Ballistic Missile Division of the Air Force.

This versatile system helped deliver the nose cone of a Thor-Able test missile precisely to its South Atlantic target area—5000 miles from Cape Canaveral, Florida. So accurately was the nose cone placed that a waiting group of ships and planes retrieved it in a matter of hours. It was the first nose cone ever to be recovered after so long a flight.

The command guidance system which made such accuracy possible combines precision tracking radar with a special Remington Rand Univac computer. Fed a steady stream of signals from the missile-borne transmitter, the ground-based equipment compares the missile's flight path with the preselected path. Corrective steering orders are computed and transmitted automatically to the missile. The ground station monitors the progress of the flight continuously and obtains immediate evaluation of mission success. And since the principal control equipment is kept on the ground, expendable hardware in the missile itself is minimized.

This radio-inertial guidance system is a product of the Bell Laboratories-Western Electric development-production team. It is in production at Western Electric for the first operational squadrons of the Titan intercontinental ballistic missile.

Bell Labs scientists and engineers developed the world's most versatile telephone network and much of our nation's radar. They have constantly pioneered in missile systems. From their storehouse of knowledge and experience comes this new achievement in missile guidance.

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– the only small organ with two full 61-note keyboards and 22 stops. Requires only 2' x 3'2" floor space! Commercial value approximately $1600 or more – yet you save over 50% when *you* build this thrilling instrument!

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Give Your Family A Lifetime of Musical Joy With A Magnificent Schober ELECTRONIC Organ!

Now you can build the brilliant, full-range Schober CONSOLETTE or the larger CONCERT MODEL with simple hand tools. No skills are necessary to construct an instrument with one of the finest reputations among electronic organs. No woodworking necessary – consoles come completely assembled and finished. All you do is assemble clearly marked electronic parts guided by clear illustrations and detailed step-by-step instructions. Even teen-agers can assemble the Schober! You build from kits, as fast or as slowly as you please . . . at home, in spare time – with a small table serving as your entire work shop!

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The coupon will bring you a handsome 16-page booklet in full color describing Schober organs in detail, plus articles on how easy and rewarding it is to build your own organ and how pleasant and quick it is to learn to play the organ. In addition, we have prepared an exciting 10" hi-fi LP record demonstrating the full range of tones and voices available on the Schober, which you may have for only $2.00 (refunded when you order a kit). Literature on the Schober is FREE! There is no obligation; no salesman will call.

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2248 Broadway, New York 24, N. Y.

☐ Please send me FREE full-color booklet and other literature on the Schober organs.

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Name.....

Address.....

City..... Zone... State.....

CORRESPONDENCE *(Continued from p. 18)*

In many bigger cities engineers and technicians are doing part-time servicing. Many of them have had years of experience in design and in testing completed receivers. There are several reasons why these men want to do part-time service work. Some need money to buy shop equipment. Some want to keep up with current practices. And still others get satisfaction out of completing a tough repair job.

I remember a toughie a friend of mine recently completed which had been turned down by two regular full-time repair shops as impossible (or not worth doing?). It was a tiny personal portable which had played well when new, but later went entirely dead. One big mystery about this set was that it had absolutely no identification of any sort on it, inside or out. There was no name, label, schematic or manufacturer shown anywhere. The tubes were flat subminiatures, and one was missing. Even after the right type was found and put in place there was still no music. It was found that a wire from the tuning capacitor had never been soldered to the oscillator coil. It was lying close to the coil terminal and apparently had originally touched the coil lug. After this connection was soldered the set worked, and after alignment of the ifs it played loud enough to show that the speaker voice coil was rubbing. It took a lot of looking, through every available catalog, to find the exact replacement. When the new speaker was installed, the little portable played better than it had when it was new! This is a typical instance in which a full-time service technician couldn't afford to repair the set. This part-timer friend of mine picks up numerous repair jobs from service shops which he completes for them.

Another place for the part-time service technician is in the building or repairing of test equipment for full-time repair shops. Many radio and TV repairmen don't have the time or training to keep their test equipment in repair. There are also test equipment kits they'd like to own if they had time to build them. I know another engineer who builds kits and repairs test equipment for service shops in his spare time.

There's still another place for the spare-time technician if he has a commercial radio operator's license. Since most rural communities have their own police and fire departments with radio transmitters and receivers, they need service technicians to keep this equipment operating. And many radio and TV broadcast stations need one or two part-time men.

You can see that the part-time service technician does have a place in our industry. He supplements rather than takes the place of full-time repairmen. Working together, they will do a good job of keeping the radio and TV sets and other electronic equipment of our nation in good operating condition.

JAMES A. FRED

Russiaville, Ind.

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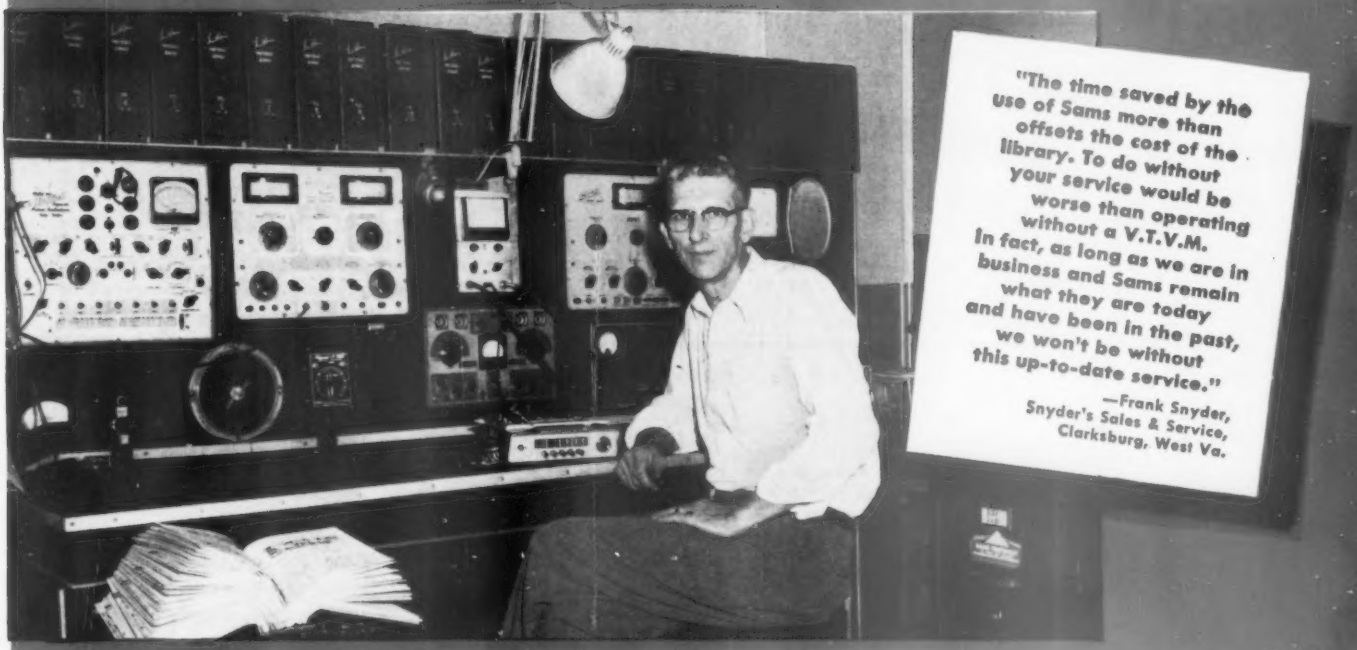

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—Frank Snyder, Snyder's Sales & Service, Clarksburg, West Va.

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"I would not take anything for my valuable collection of Sams PHOTOFACT."
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"My PHOTOFACT library is an indispensable source of service information on the...TV sets serviced in our shop. Without this information, the time required to complete many repair jobs would be prohibitive."
—Richard Huntley, *Craigmont, Idaho*

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"With the PHOTOFACT file to back us, we have complete confidence that we can handle any service problem brought to the shop."
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—T. A. Hopkins, *Quanah, Texas*

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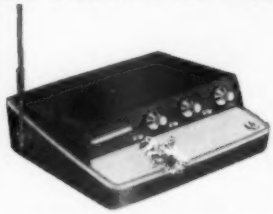

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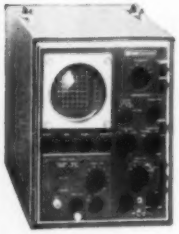

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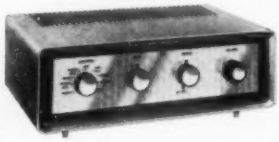

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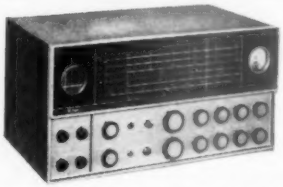

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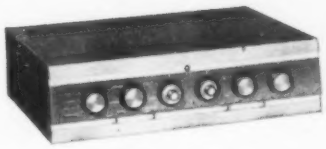

Y-774 Deluxe 40-Watt Stereo Amplifier (with Center Channel)..**$79.50**
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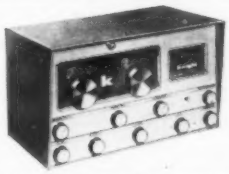

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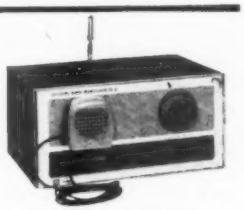

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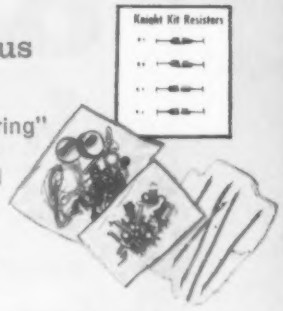

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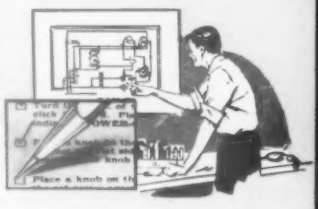

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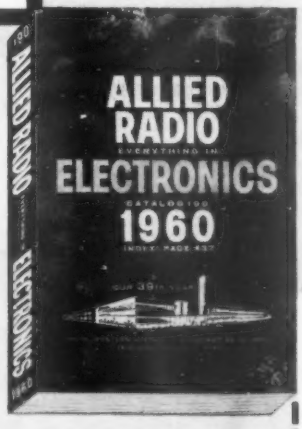

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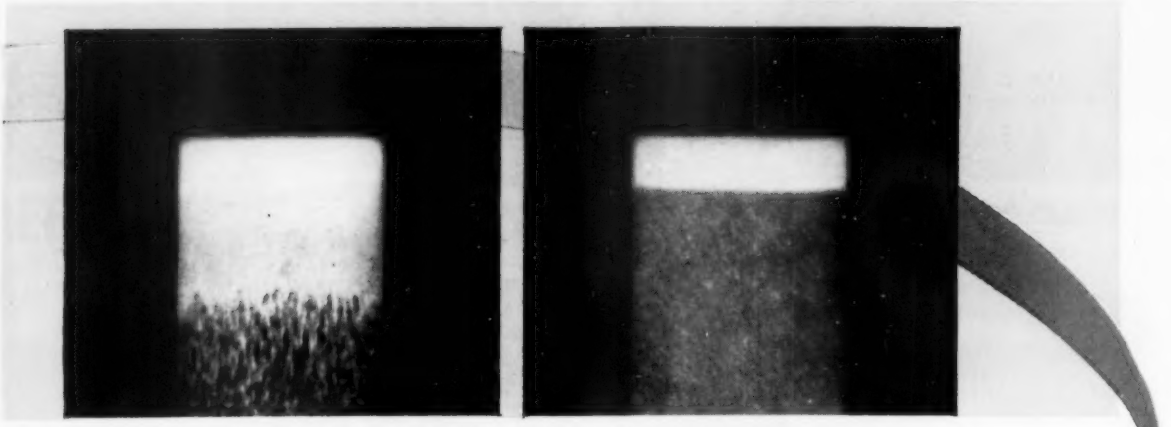

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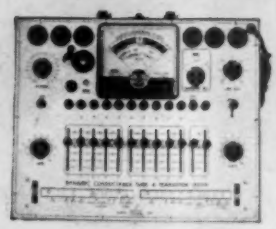

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A Tests all receiving tubes (picture tubes with adapter), n-p-n and p-n-p transistors. Composite indication of Gm, Gp & peak emission. Simultaneous selection of any one of 4 combinations of 3 plate voltages, 3 screen voltages, 3 ranges of continuously variable grid voltage (with 5% accurate pot.). Sensitive 200 ua meter. 10 six-position lever switches: freepoint connection of each tube pin. 10 pushbuttons: rapid insert of any tube element in leakage test circuit. Direct reading of inter-element leakage in ohms. New gear-driven rollchart. **CRA Adapter $4.50.**

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C 150 kc to 435 mc with ONE generator in 6 fund. bands and 1 harmonic band! ±1.5% freq. accuracy. Colpitts RF osc. directly plate-modulated by K-follower for improved mod. Variable depth of int. mod. 0-50% by 400 cps Colpitts osc. Variable gain ext. mod. amplifier: only 3.0 v needed for 30% mod. Turret-mounted, slug-tuned coils for max. accuracy. Fine and Coarse (3-step) RF attenuators. RF output 100,000 uv, AF output to 10 v.

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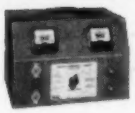

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ELECTROMYOGRAPHY

. . . *Electronics' Newest Medical Tool* . . .

IN 1791, Luigi Galvani first observed that a frog's freshly skinned leg muscles reacted strongly to a weak electric current. He also noted that an electrical current in turn was generated during muscular contraction.

Electromyography (*Myo* = Greek for muscle + *Graphos* = Greek, to write), a new medical technique, goes back to 1939. It has already joined the older electronic medical tools, the electrocardiograph used in heart diagnosis and the electroencephalograph in brain investigation.

The electromyograph is fast becoming an important tool in the up-to-date physician's office for the evaluation of neuromuscular disorders. The instrument is a very sensitive cathode-ray oscilloscope with a high-gain audio amplifier. It also can record both visual and audio action potentials permanently on tape.

This is what the electromyograph does:

1. It analyzes the amplitude of the individual muscle action, its potential, duration and waveform.
2. It records muscle action following electrical stimulation of the connecting nerve.
3. It analyzes muscle coordination.

In addition, it gives the physician other technical data in muscle pathology. Thus any physiologic dysfunction that normally interferes with the propagation of an impulse down an axon (nerve cell) can be readily investigated with the electromyograph.

Since many physicians and technicians are as yet unfamiliar with the new instrument, a simple description of the myograph and procedures followed in its use are given here in the words of Dr. Barnard S. Post of the Department of Electromyography, St. John's Episcopal Hospital, Brooklyn, N. Y.:

"The instrument consists of a number of electronic devices coupled together in such a manner that the waveform of the electrical potential in a muscle may be accurately depicted on a cathode-ray oscilloscope screen. Conversion of the same potential into an audio component is accomplished through the use of a loudspeaker driven by an audio amplifier. This is very valuable since each variation of waveform has a characteristic sound which is different from all the others and which, after some experience is gained, enables one to identify the type of wave just by its sound. The individuality of the sounds depends on the frequency of the waves plus their amplitudes. Permanent records may be made on film, magnetic tape, or on graph paper with the use of d'Arsonval galvanometers and penwriters.

"The electronic components which are combined are: A preamplifier having a very high noise-rejection ratio and a flat response to low frequencies and containing high-frequency cutoff circuits. This preamplifier's output is fed into a multistage amplifier of sufficient gain to produce an increase in the signal value of approximately 100,000. This amplifier is designed to produce the absolute minimum of waveform distortion possible. The output stage of this amplifier is then fed into the vertical input of the oscilloscope and into the tape recorder which magnetically scribes the examination for restudy when convenient. Pictures of the waveforms may be photographed later during the playback of the tape by arranging a trigger mechanism in the sweep circuit of the oscilloscope. This trigger synchronizes the sweep with the shutter of the camera. While the waveforms are being recorded on tape, so is the audio component, thereby also synchronizing the picture with the sounds. For the sake of clarification, it might be better to state that the waveforms can be converted into sounds only because their frequencies fall within the spectrum audible to the human ear (up to 15,000 to 20,000 cycles per second)."

The myography art has evolved a number of special insulated electrode needles or probes which are directly inserted into the affected muscle, much as one uses the usual hollow-needle hypodermic syringe. These are used to connect the patient's affected muscle or muscles into the circuit.

The electrode needles do not cause more pain than felt during a normal antibiotic "shot." The new needles differ from the standard hypodermics in that no liquid drug is used. Various types of needles are used—the most common one, the single wire coaxial, has a single wire within the hollow needle, the end of the wire and the needle tips contacting the muscle. The double- or two-wire coaxial has two wires, both of which contact the muscle. In this case, the needle body does not act as an electrode. The needle, always sterilized prior to use, is inserted rapidly in the affected muscle to be examined.

The patient, just as in electrocardiography, is provided with a grounding electrode which is made highly conductive by means of the usual alkaline paste. This is necessary because a low-resistance path for extraneous signals, which the body often picks up, must be provided. Furthermore, larger voltages are usually present in the body tissues.

Interesting, too, are the facts that the heart muscle has an output in millivolts, while voluntary muscles generate microvolts, and, furthermore, that a patient cannot influence the readings of the instrument.

The following is a condensed list of the various dysfunctions or muscle impairments that are now studied and diagnosed by the electromyograph:

Neuromuscular disorders; nerve blocks; protruding intervertebral disk (testing for location); muscular dystrophy; primary muscle atrophy; spinal muscular atrophy; poliomyelitis (examining persons desiring to qualify for aid fund); impaired muscle re-education (used as a treatment in re-education); conditions which produce tremors, spasticity, rigidity, etc.; and—possibly the most valuable use of the electromyograph—is detecting the first signs of regeneration in peripheral nerve lesions. —*H. G.*

Contracting ceramic makes high-impedance voltmeters, loudspeakers that don't need magnets or voice coils, and solid-state relays

ELECTROSTRICTIVE CERAMICS

opens new design vistas.....

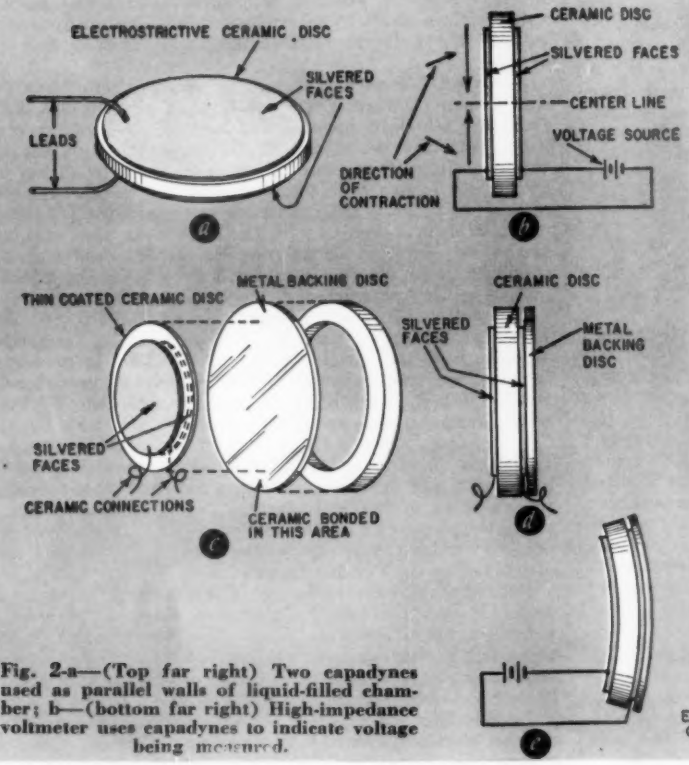
By RUFUS P. TURNER*

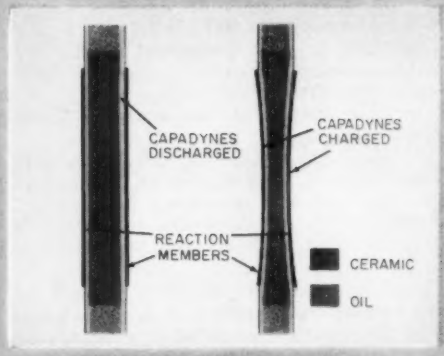
SOLID-STATE research and development continues to provide intriguing new components for electronic circuits. One recent device uses a little-known effect, *electrostriction.*

Electrostriction is the contraction of a material when a voltage is applied to it. The amount of shrinking depends upon the voltage. When the voltage is removed, the material springs back to its original size. The material can be made to vibrate by modulating or interrupting the applied voltage. Thus, electrostriction is the dual of magnetostriction—the condition in which rods or bars of certain metallic alloys stretch or shrink under the influence of an applied magnetic field. However, the important difference is that while magnetostriction requires a continuous flow of current in electromagnetic coils, electrostriction demands practically nothing but voltage to do the job (the only current being the initial, short-time "displacement" flow required to charge the capacitance of the ceramic dielectric, and the tiny leakage current flowing through the ceramic's extremely high resistance). Thus, power is required to obtain mechan-

*Author, *Transistors, Theory and Practice,* Gernsback Library.

Fig. 1—Electrostrictive ceramics: a—Silvered faces on specially treated ceramic disc are electrostrictive electrodes. b—How electrostrictive disc is hooked to voltage source. c—Exploded view shows ceramic loudspeaker elements. d—Fastening metal disc to one electrode gives simple method of amplifying disc's contraction; e—Contracted disc with a metal face distorts into cup-shaped form when voltage is applied.





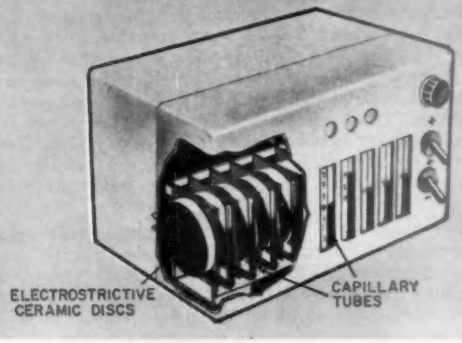


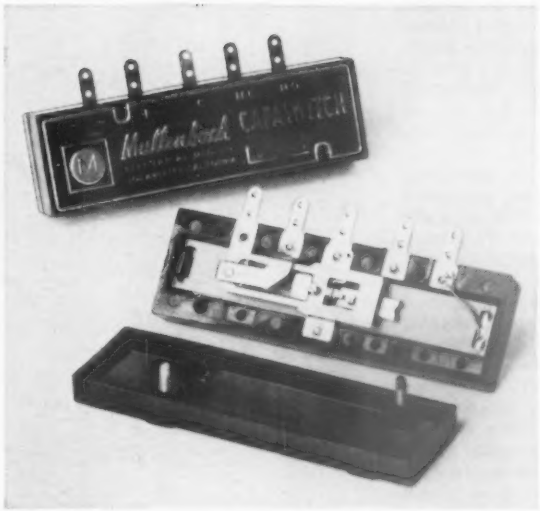
Fig. 2-a—(Top far right) Two capadynes used as parallel walls of liquid-filled chamber; b—(bottom far right) High-impedance voltmeter uses capadynes to indicate voltage being measured.

ical movement in magnetostriction, but virtually no power is needed for electrostriction. So the impedance of an electrostrictive device is high, an important feature in many electronic application.

One electrostrictive material is barium titanate. Mullenbach[1] scientists process this substance to yield electrostrictive effects. Certain chemical additives impart this unique property to a material which, in other forms is already used in capacitors, phono pickups, computer memories, shift registers, flip-flops, vibration and pressure transducers, and dielectric amplifiers. An important objective of the processing is to minimize the familiar piezoelectric effect in the barium titanate.

Fig. 1-a shows the heart of the electrostrictive mechanism. Construction is simple. Each face of a thin disc of specially processed barium titanate is coated with a silver film which might be applied by firing, vacuum deposition or cathode sputtering. These films are the electrodes. In its construction, the unit resembles a disc type ceramic capacitor (and it is indeed a two-plate capacitor with a high-K—(high dielectric constant)—electrostrictive dielectric).

When a voltage is applied to the plates, as in Fig. 1-b, the ceramic disc shrinks in radius. The manufacturer's specifications for a disc 3 inches in diameter and .02 inch thick shows a displacement of 2/1,000 inch when 200 volts are applied. The capacitance of such a disc is .08 μf and its leakage resistance 100 megohms.



Early version of Capaswitch made by Mullenbach Electrical Mfg. Co.

Mechanical motion is amplified in an ingenious, yet simple, way. A metal disc is bonded to the electrostrictive element (see Fig. 1-d). Now, when a voltage is applied to the electrostrictive element, the contraction makes the entire assembly distort into the cup shape shown in Fig. 1-e. The bending action resembles that of a bimetallic thermostat strip. This complete assembly of electrostrictive capacitor and metal disc is called a *capadyne*.

[1]Mullenbach Div. of Electric Machinery Manufacturing Co., Los Angeles, Calif.

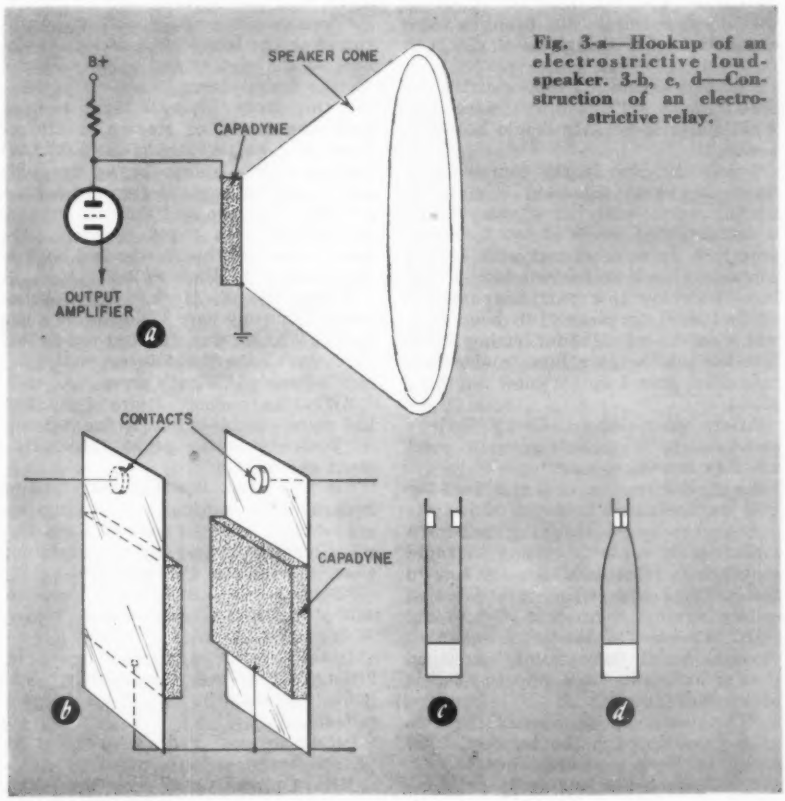


Fig. 3-a—Hookup of an electrostrictive loudspeaker. 3-b, c, d—Construction of an electrostrictive relay.

What can they do?

Capadyne elements already have been tested extensively in several applications. In some tests the capadyne is used as an actuator which draws almost no power from its voltage source, but remains continuously displaced. In a comparable electromagnetic type device, *power* must be supplied continuously.

Fig. 2 shows capadynes in an experimental voltmeter which has an extremely high impedance and may be able to perform many of the measurements previously possible only with vtvm's and electrostatic voltmeters. The basis of this unit is the arrangement illustrated by Fig. 2-a. Two capadynes are mounted back to back to form the parallel walls of a chamber. When a voltage is applied to the capadynes, they cup inward (as shown on the right-hand side of the diagram) and accordingly narrow the chamber. If the chamber is filled with oil, mercury or other suitable liquid and has a vertical outlet tube, the excited capadynes squeeze the liquid out of the chamber and up into the tube when they are excited. The liquid runs back into the chamber when the exciting voltage is removed. The height of the liquid in the tube is proportional to the voltage. In Fig. 2-b, several such electrostrictive units are shown mounted side by side in a multirange voltmeter. Since the capadyne units are thin, a number of these indicators might be mounted in a single instrument. An obvious advantage of the electrostrictive voltmeter is that it does not require a continuous current to maintain its reading. Pilot production models of electrostrictive voltmeter elements provide a 0–200-volt range (either polarity) with a scale length of 2½ inches. Deflection is proportional to the square of the impressed voltage. The capacitance of each capadyne disc in the element is 0.16 μf.

Fig. 3-a shows how a lightweight high-impedance speaker employing the electrostrictive principle might be made. A capadyne disc is attached to a speaker cone by some suitable mechanical fastening. Vibration of the disc, caused by an impressed audio-frequency voltage, is conveyed directly to the cone. Since the capadyne unit is essentially nonconducting, it can be connected directly to the output stage of an audio amplifier. If the capadyne frequency response can be made suitable, such construction would eliminate the heavy magnet and low-impedance voice coil from the speaker and would greatly simplify coupling to the amplifier.

An electrostrictive relay is available commercially.[2] The principle of this unit is illustrated by Figs. 3-b, c and d. A rectangular electrostrictive element is bonded to each of two parallel strips of thin flexible metal as shown in Fig. 3-b. Each strip thus forms a single capadyne. The strips are fastened permanently at their lower ends, mounted close together, and each has a contact on the inside of its free tip.

When the relay is unenergized, the strips stand open (Fig. 3-c). When an exciting voltage is applied simultaneously to the two capadynes, they bend toward each other and close the contacts (Fig. 3-d). Advantages of this relay are:

- It is essentially voltage-operated and therefore high-impedance.
- It requires no holding current, the only post-closure current being the small leakage current through the extremely high resistance of the ceramic (often 100 megohms).
- Having no coils, it is immune to many of the disturbing effects of nearby magnetic fields.

Things to come

Many applications aside from those just described are apparent. Capadyne discs are available, so a great deal of individual experimental and development work may be expected in the near future.

Some of the applications which immediately suggest themselves are:

- **Electrostrictive amplifier.**
- **Electrostrictive buzzer (similar to Fig. 3-b but with one capadyne strip and one external, stationary contact).**
- **Electrostrictive chopper.**
- **Nonmagnetic driver for vibrators, underwater sound generation and supersonics.**
- **Frequency control device (similar to quartz crystal) for audio and subsonic oscillator stabilization.**
- **Transducer, voltage to pressure.**
- **Valve control.**
- **Electrostrictive modulator.**
- **Pressure generator. (Stacked capadynes have been used to produce 30,000 pounds per square inch on application of 200 volts.)**

As materials and components continue to improve, electrostriction may be expected to take over some of the electronic functions formerly performed exclusively by electromagnetism. END

[2]The *Capaswitch.*

PEDRO and the SWAMI

The industrial service technician runs into a tough one

By GUY SLAUGHTER

"PEDRO," I said into the handset. "This is nuts. I don't even know what I'm looking for."

"You're looking for the relay that drops out first," the familiar voice came back. "It should be a cinch to find."

"Sure it should," I replied, with my best sarcasm. "There aren't more than a million or so here. It should be a real breeze."

I was standing in the control basement of one of the local steel mills, staring suspiciously at a relay panel which extended maybe 50 feet each way from me. It was covered with relays, contactors and knife switches. I had been watching this particular section of the panel for nearly an hour now, which served me right for letting Pedro talk me into helping him troubleshoot industrial gear I didn't know anything about.

"Here we go again, Herk," Pedro's voice called. "The line's going to start up. Pay attention, now."

I sighed in resignation and fixed my eyes on the panel in front of me. At once there was the snapping clack of a multitude of contacts closing in rapid sequence as armatures all up and down the control board picked up and seated solidly against their coils. Off to my right the arm of the motor-operated rheostat began its rotation, described its arc and came to a stop two-thirds of the way around.

"The line's up to speed," Pedro's voice came through the handset, "750 a minute. Keep your eyes open."

"Yeah, yeah I'm looking."

Fifteen minutes later I was still looking, while the sense of urgency I'd been feeling grew stronger. The motor-operated rheostat was holding at its two-thirds position. Most of the relays on the board were sealed in. The hum of the motors and generators upstairs carried down to me as a sleep-inducing drone. My eyes began to burn from the strain of staring. I blinked them to ease the strain. And at that precise instant relays began dropping out with the staccato clatter of machine-gun fire, first one and then all the rest on the panel in rapid sequence. The motor-operated rheostat buzzed back to zero, clicked its limit switch.

"That was it, Herk," Pedro yelled excitedly in my ear. "The line is down again. Which relay dropped out first?"

"I don't have the faintest notion," I said solemnly. "What's more . . ."

"Whattya mean?" Pedro demanded, his voice climbing like a fire whistle.

"You're standing right there. How could you miss it?"

"It was easy. But I'm not standing here another minute. I'm coming upstairs right now. Of all the darn fool ways you've figured out to waste my time, this one is the worst!"

"Don't get teed off, Herk," the voice said pleadingly. "Just once more, please. We've got to find it."

I debated for a moment, gave in. "Okay," I sighed resignedly. "Once more. But make it fast. That doggone coffee. . ."

"Here we go," Pedro's voice cut in. "Keep your eyes open, now."

Relays picked up all over the board,

and the motor-operated rheostat began its climb. "There's 750. Watch those relays."

I watched them. For what seemed hours I watched them. And nothing happened. Finally, I couldn't stand it any longer.

"Pedro," I said into the handset. "I'm coming up. I've had it."

"Just a couple more minutes, Herk. It's bound to drop out any second again."

Disconnected and disgusted

I didn't answer. Instead, I pulled the handset plug from the jack in the relay panel, stuck the instrument in my pocket and headed for the stairway. The noise of the operating floor grew thunderous as I climbed and, when I reached the top of the stairs, my ears were assailed by the hum of heavy machinery, the whine of the steel strip moving through ponderous rolls at hundreds of feet per minute and the clank-clank of the flying shear cutting the strip into yard-long sheets at the end of the line. Pedro met me a dozen steps from the stairway. His eyes were puzzled.

"It's so darn irregular, is what's got me beat. One time it'll kick out in just a few seconds. Next time it'll run maybe a quarter of an hour."

"Yeah, tough. Well, let's get out of here."

"You crazy?" Pedro wanted to know, giving me the troubled eye. "We can't leave. Not 'til we find it, anyway."

"You want to bet? I'm sorry they've got troubles. But I've got troubles of my own."

"Herk," Pedro said coldly, showing me the old frown, "Herk, this is serious. The line can't run until we find out which piece of electronic gear is tripping out its line-stop relay. We've been hired to do a job here, and we can't run out. . ."

"We?" I cut him off. "*We* can't leave, and *we've* been hired?"

Pedro's face assumed the color of an overloaded rectifier. "*We*," he echoed, flatly. "*They* called *me* in, and *I* called *you* in. That makes it *we*. And anyway, I need your help. For the honor of all radiomen everywhere, we've got to find the trouble."

"Oh, great," I groaned. "Here we go with that 'get-in-there-and-fight' stuff again."

"Sure," Pedro continued. His grin was back now, and he winked at me. "The future of industrial electronics is in our hands."

"Go-go-go," I murmured. "Old buddy, how do you know the trouble's in the electronic gear? Maybe one of the drive motors is kicking out on overload or something."

"The mill electricians have already checked their own gear," Pedro replied. "They've even shorted out all the oil-pressure switches and stuff with jumper wires, but still the line kicks out. So all that's left is the electronic equipment."

"But why pick on me? I don't know anything about this gear, and I'm not sure you do either."

"Yes, I do," Pedro said calmly. "And so do you. I've worked this stuff over before, and it's routine electronic circuitry, most of it. There isn't a piece of stuff in the place you couldn't bug out if you wanted to."

"Thanks, but I don't want to. So you do it." I turned to leave him, but he grabbed my elbow.

"Wait," he almost wailed. "I need your help. The thing is, the trouble's not in the gear itself. It's in one of the line circuits associated with it. Every piece of equipment in the place is interlocked into the line-stop circuit, so that failure will stop everything dead. And one of the interlocks is dropping out. We've just got to find out which one."

"Okay," I agreed, surrendering for the dozenth time that day. "But there must be a better approach than for me to stare at a million relays for hours on end, hoping to catch the culprit in the act."

"Any suggestions?" Pedro wanted to know.

"Not a one. You think about it, and I'll be right back. I've got an errand."

I headed for the washroom on the far side of the building, and went in. When I came out, the line was just starting up; it had been running a moment before. I stood there, while the line came up to full speed, thinking about that. Then I went back into the washroom. The line was down again when I came out a moment later. I grinned to myself, happily.

Enter the swami

Pedro was wearing his most harried look when I found him. He was examining the continuous-running time chart which showed, with an inked path along a paper strip, the speed of the line during every minute of every day. The section of chart he was staring at was a mess of inky zig-zags, like an oscillograph of a noise pulse, showing how the line had started and stopped dozens of times in a few hours.

"Having consulted my crystal ball," I chuckled gaily, "I am in a position to solve your problem."

"You and your jokes," the glum Pedro responded, not looking up from the chart. "I'm convulsed."

"Swami does not joke," I intoned smugly. "Swami is all-seeing."

"You got a clue?" he demanded, letting the chart roll up on its spring-loaded mandrel.

"Water," I said. "What pieces of electronic gear are tied in with water?"

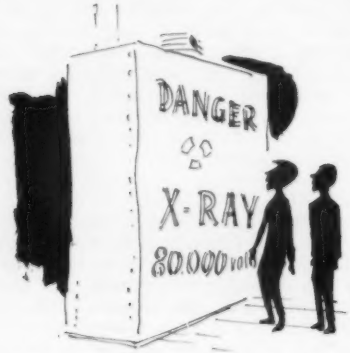
Pedro pondered a moment. "Just two. The seam-welder ignitrons are water-cooled, and so is the X-ray gauge."

"Check 'em over. There's your trouble."

Pedro didn't hear me. "But the welder doesn't run continuously," he was saying, evidently to himself. "Only when a coil of steel runs out and the operator welds in a new one. Yet the line stops any time, during the weld or not. So that leaves the X-ray gauge." He looked up at me, grinning. "Hope you're right, Herk. Come on."

I came. He led the way to a big, steel-cabineted device parked alongside the line about halfway down. The cabinet bore a painted-on legend: Danger—X-Ray equipment—80,000 volts.

Connected to the cabinet by a shielded cable an inch in diameter was another piece of equipment, a 3-foot long, U-shaped affair, through the open ends of which the steel strip ran on its way from the tin-plating tanks, past the melter and oiler towers, and on toward



the hole-detecting equipment and the flying shear.

"That's the X-ray head," Pedro explained, pointing at the U-shaped device. "The X-ray tube is in the part on top of the strip, and there's an electron-multiplier photocell in the part under the strip. The gadget gauges the thickness of the strip continuously." He jerked a thumb at the cabinet alongside us. "The power supplies, dc amplifiers and comparator circuitry are in there."

"What's water used for?" I asked, bewildered.

"Cooling the X-ray tube, stupid," Pedro grinned. "What else?"

"Yeah," I said. "What else? But what's the connection between it and the line-stop circuits?"

Pedro shrugged. "Beats me. Unless there's a pressure switch in the water line. We'll have to check."

He crawled around on the floor, under the strip, which ran horizontally here about 3 feet above the floor. After a minute, he beckoned me to join him. I ducked under the moving strip reluctantly, looked where he was pointing. There was a water line there, sure enough, of ½-inch galvanized pipe. And strapped to the water pipe was a foot-square steel box, maybe 6 inches deep, its top a flat sheet of steel held on by four screws. Pedro was already working on them with a screwdriver. He removed the top, peered inside. I crept closer for a better look. Inside the box was a transformer whose primary leads disappeared into the cement floor through a piece of conduit, and whose secondary leads were clamped securely to the water pipe, about 6 inches apart. In the center of the 6-inch pipe section between the clamps, a small, black object resembling a microswitch was strapped to the water line. A pair of leads from it also disappeared into the same piece of conduit.

"Interesting," I said. "Most interesting. What is it?"

Pedro grinned at me happily. "Can't you guess, Herk? I can. Instead of a pressure switch in the water line, the X-ray gauge manufacturer used a thermal protector. That transformer must be a current affair which feeds a few amperes through that short section of water pipe. A normal flow of water prevents this current flow from heating the pipe significantly, while a water failure kills the cooling action and makes the pipe-and-transformer into a regular solder gun. The gizmo that looks like a microswitch must be a bimetal thermal cutout interlocked into the line-stop circuit through one of the relays on the board downstairs. If the water fails, the pipe gets hot, the thermal cutout opens and the relay drops out. Simple and easy, huh?"

A fluid situation

It proved to be just that simple. I watched while Pedro hunted up one of the electricians, got him to bring us a handful of blueprints, and finally found one that showed an interlock relay in the line-stop circuit whose coil was fed through a thermal cutout.

"There it is," Pedro told the electrician, pointing out the relay in question. "Block that one in, and you're back in production. Then you better have a pipefitter check out the water line to the X-ray gauge and see what's lousing up the flow. Maybe that particular run of pipe is corroded almost shut, or maybe the trouble is in the pressure line to this whole end of the mill. Anyway, I've shut down the X-ray gauge until he gets the water fixed, and told the production operator he'll have to check the strip with a mechanical gauge meanwhile."

The electrican grinned and trotted off. Pedro turned to me.

"Okay, Herk, give. What's this crystal-ball stuff?"

"I don't know *how* I do it," I said. "Sometimes it frightens me. It must be a gift. Like telepathy, or clairvoyance, or. . ."

"Hold it, Swami," Pedro said testily. "When I turn in our bill, they'll ask me how we found the trouble. Shall I tell them it came to you in a vision?"

"No, I guess not." I grinned at him. "Just tell them I noticed that the line stopped whenever I flushed the toilet, and. . ."

"That's enough," Pedro said. "I'll take it from there."

And he did. . . . END

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Industrial electronic weighing system in action. *Courtesy Streeter-Amet Co.*

Technicians look at ELECTRONIC WEIGHING SYSTEMS

Part I—More dollars for the electronic technician, if he can keep an electronic scale working. Here's the story

By EDWIN BOHR

INDUSTRIAL electronic weighing installations are becoming more and more common. From fueling moon rockets to weighing moving highway trucks and railway cars, the versatility of electronic weighing is unchallenged.

Such installations have extremely interesting instrumentation and electronic circuits. They are unlike anything seen in TV or radio. Industrial technicians in particular will find the circuits novel and challenging.

How they work

All commercial electronic weighing systems (with rare exceptions) measure the slight elongation or shortening of a piece of tool steel. Tool steel behaves like a very precise and accurate spring.

For example, in Fig. I–1 we show a piece of steel rod 1 inch long. If 10 pounds placed on top of the rod shortens it 1/1,000,000 inch, 20 pounds will shorten it 2/1,000,000 inch. When the weight is removed, the steel immediately returns to its original length of exactly 1 inch.

Length continues to vary almost exactly in proportion to the weight or force on the rod until the rod has changed by about .003 inch. (This, of course, depends upon the properties of the particular steel used.)

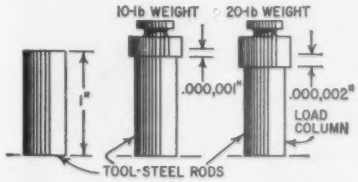


Fig. I–1—Length of tool-steel supporting column changes in direct proportion to weight it supports.

If excessive tension or compression is applied, the steel may not return to its exact original length. However, all electronic weighing systems can withstand severe overloads without permanently changing calibration.

The absence of lever arms, balances or other mechanical parts, and immunity to shock and vibration are obvious advantages of electronic weighing. After all, the sensing device is as rugged as tool steel.

Infinitesimal changes in length of the steel supporting bar (called a load column) are measured electronically.

To do this, a special resistor, called a strain gauge, is cemented to the load column. The gauge is a grid-shaped resistor etched (like etched-circuit boards) upon the surface of a very thin plastic, or fabricated from very fine resistance wire cemented to a paper

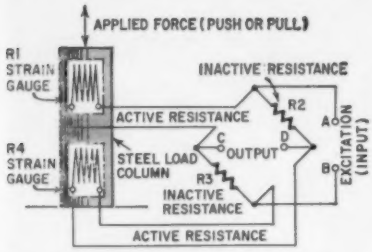


Fig. I–2—Two strain gauges are attached to load column and are connected to inactive resistors R2 and R3 to form Wheatstone bridge.

backing. The backing is extremely thin but insulates the resistor from the load column.

Because of the intimate bond of strain gauge to load column, the gauge follows any expansion of contraction of the column. As the load column *decreases* in length, the strain-gauge resistance *decreases* and vice versa.

The resistance of the strain gauge is a direct indication of the load-column length. However, the resistance change from no load to full load is *very small* —generally less than 0.5%. For high resolution and accuracy, the measuring instruments must *detect and measure resistance changes of .0005% or better.*

Measuring circuits

Fig. I–2 is a practical circuit for detecting load-column length changes. Two strain gauges (R1 and R4) are bonded to the load column in the same direction as the forces on the column.

These active resistances, as they are called, are connected to precision resistors (R2 and R3) in a Wheatstone bridge and an excitation voltage is applied. The four resistors are exactly equal in resistance so, with no load on the column, there is little if any output voltage (or potential difference) from terminal C to D.

If the load column is tensed or compressed, the bridge is unbalanced and a voltage proportional to the weight or force appears across terminals C and D.

If the force is *compression,* terminal C develops the same polarity (or instantaneous polarity) as terminal A, and terminal D the same as terminal B. *Tension* causes exactly the opposite: C has the same polarity as terminal B and D the same as terminal A. The polarity (or phase) of the output changes when the load column goes from compression to tension.

The combination of load column, active resistors, inactive resistors and protective housing is called a load cell. Typically, the load cell is robust in appearance and rather heavy for its size.

Most load cells are 120- or 450-ohm units, with probably more 120-ohm units in operation than any other type. The resistance refers to the input resistance or the resistance the excitation voltage must feed. It is also the resistance of each leg of the Wheatstone bridge, since four equal resistors connected in series-parallel have a total resistance equal to any single resistor.

We have simplified the load cell's construction. Some units are based on lever action, others contain as many as 16 strain gauges. Small series resistors compensate for variations of the steel's elasticity.

The maximum excitation or input voltage depends upon the power-dissipating abilities of the resistors within the load cell. Too much excitation causes excessive heating and resistance drift. Very high excitation voltages, of course, may permanently upset the resistance balance or even produce burnout.

Load cells, on the average, provide about 2-mv maximum output for each volt of excitation. If the excitation voltage is lower than optimum, extreme difficulties arise because of the very poor signal-to-stray-noise ratio.

Generally, 6 volts is applied to 120-ohm load cells and 20 volts to 450-ohm cells.

Weight indication

So far, we have found that electronic weighing measures the mechanical strain in a load column by using sensitive resistors in a Wheatstone bridge to produce a voltage output proportional to the force on the load cell. Now we come to measuring the output voltage of the load cell and indicating it directly in pounds. The simplest method uses a very stable source of excitation voltage for the load cell (any change in excitation directly affects the accuracy) and a millivoltmeter connected to its output.

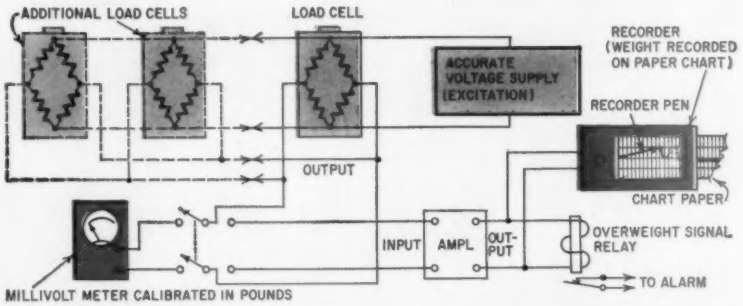


Fig. I–3—Circuit arrangement for direct indication of load-cell output.

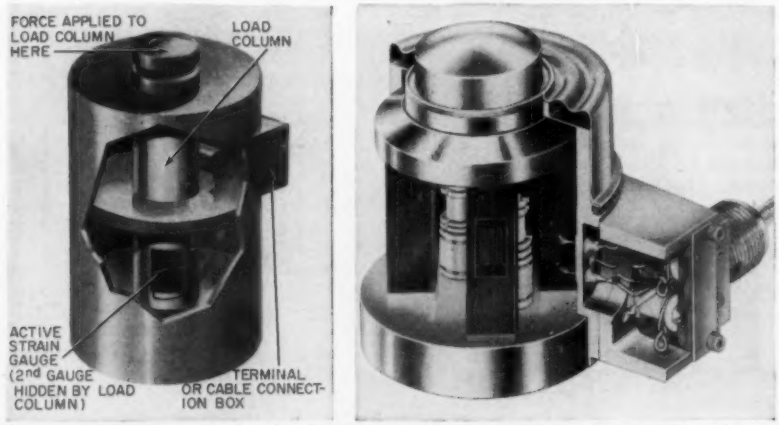
Either ac or dc may be used with ac or dc millivoltmeters. However, the accuracy of such systems is inherently limited—usually to within several percent, as compared to the closer than 1% accuracy of null-balance instruments.

Nevertheless, the system is used to measure the weight of vehicles in motion over a section of highway. A special section of roadway is supported by several load cells and their electrical outputs are added and measured by a recording ac voltmeter.

A recording voltmeter is necessary since the truck passes over the weighing section much too fast for a human observer to read the meters. After the truck has passed, each axle's weight is read from the chart.

In another application, the truck weight, if it exceeds the legal limit, trips a relay, alerting the vehicle inspection bureau to the violation.

Fig.–3 is a typical setup for directly reading the load-cell output. If load cells are connected in parallel, their outputs add or subtract according to the terminal polarity. Normally, only 450-ohm load cells are connected in


FORCE APPLIED TO LOAD COLUMN HERE
LOAD COLUMN
ACTIVE STRAIN GAUGE (2nd GAUGE HIDDEN BY LOAD COLUMN)
TERMINAL OR CABLE CONNECTION BOX

Cutaway view of two load cells. Single-column unit at left is simplified version to show internal construction. Multi-column unit on right is made by Cox & Stevens.

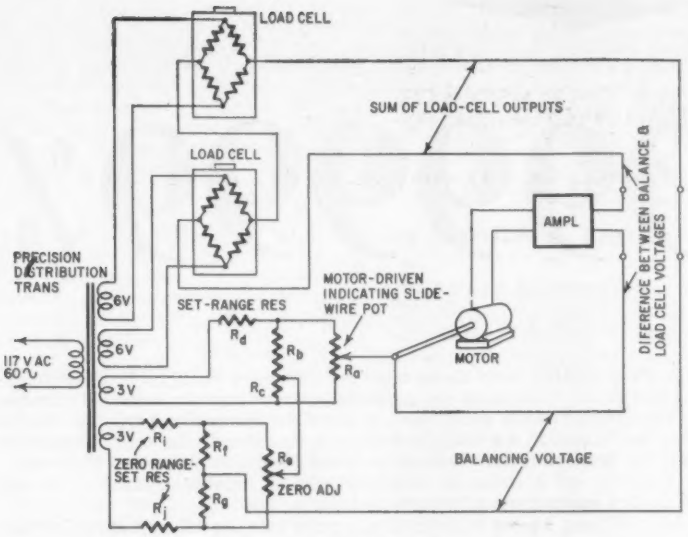


Fig. I–4—A null-balance servo system.

parallel, since low-resistance load cells in parallel suffer from errors caused by the resistance of the excitation wires.

Null-balance indicator

Null-balance indicators are commonly used in commercial weighing applications. They are inherently very accurate (in the range of 0.1%) and, with care, can indicate weight changes of 1 part in 10,000.

Looking at Fig. I–4, we notice that one or more load cells are fed from a common transformer (we have series-connected the load cells in this illustration since parallel operation is shown in Fig. I–3). With series connection, each load cell is fed from a separate winding.

The windings are accurately matched in voltage output. If they were not, each load cell, because of slight differences in excitation, would give a different output for a given weight.

Two potentiometer circuits are fed from two additional windings on the same transformer. One potentiometer is called the zero adjustment (ZERO ADJ). The other is the INDICATING or slide-wire pot. The *slide-wire potentiometer is mechanically linked to a weight-indicating dial or weight-printing mechanism.*

If we move the slide-wire contact, a point will be found where the voltage is exactly equal to the load-cell output.

An amplifier detects any difference between the slide-wire voltage and the load-cell output and causes an electric motor to turn the slide-wire contact until the load-cell output is exactly balanced. Thus the output voltage from the slide-wire follows the load-cell output. As load-cell output increases, the slide-wire rotates upscale until a balance is reached. If load-cell output drops, the motor rotates in the opposite direction until a balance is reached.

A particular advantage of the null-balance system is that variations in line voltage do not, within wide limits, affect the system's accuracy. Any variation in load-cell excitation is cancelled by equal variations in the balancing voltages.

Also, with this method, changes in amplifier gain vary only the null sensitivity (more than enough gain is usually available) without affecting the accuracy.

Resistor R_c, referring again to Fig. I–4, is a ZERO ADJUST control. It cancels electrically any unbalance in the load cell, or it may be used to cancel any fixed weight in the weighing system.

For example, if a truck is driven onto an electronic-scale platform, the scale, of course, reads the weight of the truck. However, by turning the ZERO ADJ, we can make the scale reading move back to zero, effectively subtracting the truck's weight before it is loaded.

Resistors R_f and R_g are equal. Therefore, in its center position, the zero control has no effect. Turned to either side of center, however, it will cancel either a push or pull on the scale.

Resistors R_b and R_c establish a dial zero just slightly away from the end of R_a. This makes the scale zero immune to any changes of R_d during calibration.

The weight-reading device is linked directly to the slide-wire. The three usual indicating mechanisms are: a simple pointer-and-dial arrangement; Veeder-Root type number wheels geared to the slide-wire, and number wheels that stamp the weight on a card or tape through a typewriter ribbon.

Usually, the indicators are located considerable distances from the point of weighing. In some large industrial installations, a single indicator, through a selector switch, shows weights at several widely spaced points.

Next month we continue our survey of electronic weighing equipment with a look into servicing techniques that speed repair of these units.

TO BE CONTINUED

NEXT MONTH

OTL Transistor Amplifier

An 8-watt, 8-transistor job that can be driven to full output by a ceramic cartridge. Two of them would be ideal for a humless stereo setup.

Integrated Stereo Amplifiers

Why use one instead of the familiar old pre-amp system? This question is answered and some of the features, circuit differences and outstanding points described in a survey of the integrated amplifiers now on the market.

Visual Trouble Checking

The best way to run down faults in a TV receiver is to identify them on the screen. In another of his visual diagnosis articles, A. V. J. Martin shows a series of defective pictures, tells what causes them and how they are cured.

Improved Transistor Checker

For greater accuracy and to save checking time, this instrument uses two meters. A simple construction job.

And in tune with the up-swinging fall interest in stereo and hi-fi, timely articles on developments in this rapidly expanding field.

COVER FEATURE

99.99999999% PURE

By ERIC LESLIE

Radio-frequency heating and a novel adaption of an old technique combine to give us low-cost transistors

SEMICONDUCTORS have made some revolutionary changes in communications techniques. They have also given us new meanings for some old phrases. The expression "99.9% pure" used to stand for something very close to the idea of perfection. In a world of transistors, diodes and solar cells, it describes gross impurity. Semiconductors have to be about 99.99999999% pure. This represents an impurity of 1 atom in 10,000,000,000, a number equivalent to one individual in five generations of the whole human race.

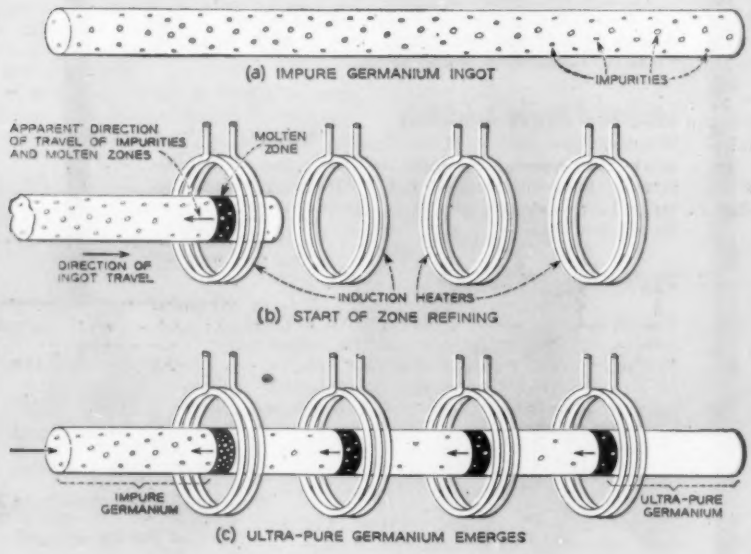
Chemists have long known how to obtain pure samples of any material that can be crystallized. The substance is melted and part of it formed into a crystal or crystals. In crystallizing, it tends to select atoms that build up the crystal lattice in a regular pattern, so impurities are pretty much left in the melted portion. (An example is the formation of ice in salt water. The salt is driven out and the ice is composed of nearly fresh water.)

To increase the purity of such crystals, the material is again melted and the larger portion of it recrystallized. This process can be repeated till a practically pure material results.

Such pure materials often act in a startlingly different way than common "99.9% pure" substances, which have one alien atom in every thousand. For example, pure water is an excellent insulator. Yet the purest water available in ordinary life is such a good conductor that a water pipe is always considered a near-perfect ground.

The germanium, silicon and other materials used in diodes and transistors do contain impurities, it is true, but these must be of the correct substances and be added in rigidly controlled quantities —quantities so small they would not be detected by ordinary "99.9% pure" methods of analysis.

How the material is purified. As the ingot (a single crystal of germanium) is moved through the heater rings, the molten zones travel along it, each carrying a fraction of the impurities toward the end.



Semiconductor purity must also be gained in a way that will keep diode and transistor production costs low, to permit their general use. The process of repeated crystallization and remelting has had its triumphs in the discovery of new elements, but the cost per gram (or milligram) of any material so made would forbid its use in most commercial applications.

The invention of *zone melting* by W. G. Pfann of the Bell Telephone Laboratories was the step that made transistors commercially practical. In this technique, instead of melting down the crystal, it is left intact, and only a narrow zone of it melted by induction from an rf heating coil, as shown in the cover photograph and the diagram. The zone is moved along the crystal, leaving the material behind it purer than that ahead. The impurities are carried along in the melted area to the end of the crystal. Several zones may be swept along the crystal, one following the other, as shown in the figure. The end of the crystal containing the impurities is then cut off, leaving ultra-pure material.

Various methods of moving the melted zones along the material may be used. A common one is to support

the crystal in a cradle of graphite and draw it slowly through a number of coils. In some setups, the crystal remains still and the coils move. Either way, the molten zone must be kept narrow enough for skin tension of the substance to keep the molten material in place. Too large a melted area might cause the material to go out of shape, or even drip. Most semiconductor crystals are made in the form of long rods. If the zone has to be kept narrow, these rods can be made with a small diameter, or the material may be cut into thin plates or even made up in the form of tubes.

Can add impurities, too

Zone melting is used for another purpose in the manufacture of transistor material. Such elements as germanium and silicon are made into p-type or n-type material by adding fantastically small amounts of impurities, usually in the order of 1 part in 100,000,000. This would be roughly equivalent to two persons in the population of the United States. Antimony might be added to germanium for an n-type crystal, indium for a p-type.

To "dope" the crystal with the infinitesimal quantity of impurity required and at the same time assure uniform doping, zone melting is again employed. A small amount of antimony is dissolved in the molten zone to produce an n-type crystal. The amount of antimony that solidifies behind the molten zone is in proportion to the amount of antimony in the melted portion. An exceedingly small amount of antimony solidifies out, so the proportion remains practically the same over the whole crystal. This makes it possible to obtain p- and n-type material of uniform characteristics, producing transistors to closer tolerances.

More to come

As great an advance as was the invention of zone melting, recent improvements have made even greater purity and lower cost possible. One of these is a *continuous process*, making for more efficient production than the crystal-by-crystal batch technique. In effect (though not in mechanical arrangement), new molten material is fed in at the center of the crystal, through which melted zones travel continuously in one direction. Pure semiconductor material is harvested at one end of the rod, while impure material is cut off at the other.

A *floating-zone* technique increases the purity even beyond the figures already given, by holding the material in a vertical position while a molten zone is swept through it by a moving coil. The crystal is supported only at the ends, which are cut off afterwards, so it is in contact with no other material. Thus any chance of contamination is reduced. Still other techniques in the laboratory stage, or starting in production, promise us even better and less costly diodes, transistors and solar cells in the future. END

DIRECT-COUPLED TRANSISTOR CIRCUITS

Surface-barrier transistors permit direct-coupled circuits

By NATHANIEL RHITA

SURFACE-BARRIER transistors have at least two rather unusual characteristics. They can operate at high frequencies (to 50 mc at least) and they require low collector voltage. Linear response results even when the collector voltage is equal to or lower than the base voltage. Thus transistors can be direct-coupled, the collector of one being tied directly to the base of the next. Several novel circuits of this type will be shown here.

Fig. 1 is a direct-coupled "saturation flip-flop" circuit. In a practical situation the load resistors may be 1,000 ohms and the supply 1.5 volts. Assume that V1 is conducting. The drop across R1 drives the base of V2 almost to ground potential, blocking this transistor. Now, if a positive pulse is fed to

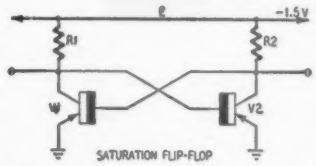


Fig. 1—Direct-coupled saturation flip-flop circuit.

the base of V1, it will cease to conduct. Its collector approaches − 1.5 volts, driving V2 into saturation. Thus one (and only one) transistor is always saturated. Furthermore, a positive pulse fed to the base of a conducting transistor will block it and at the same time unblock the other.

Fig. 1 is easily converted to multivibrator action. Capacitor C and resistor R3 must be added (see Fig. 2.)

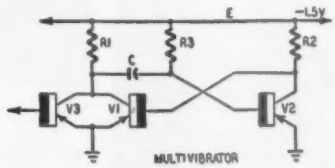


Fig. 2—Saturation flip-flop converted to a multivibrator.

Typical values are 50 $\mu\mu$f and 10,000 ohms, respectively. The third transistor, V3, controls trigger action.

Normally V2 is the saturated transistor, while V1 is the blocked one. This is true because R2 has the lower collector load value, therefore it permits larger flow. Normally V3 is blocked. When a *negative* pulse is applied to its base, it conducts and its collector approaches ground potential. A positive

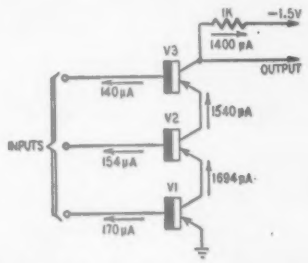


Fig. 3—*And* circuit passes current only when all three transistors are conducting.

pulse passes through C and reaches the base of V2, which blocks. Of course V1 begins to conduct and it *remains* saturated until C has had a chance to discharge. Then, V2 returns to its normal saturated value and V1 is blocked again.

Another useful circuit for surface-barrier transistors is drawn in Fig. 3. The three stages are all directly coupled. This is called an "*and*" circuit which passes no current unless V1 *and* V2 *and* V3 are *all* conducting. When

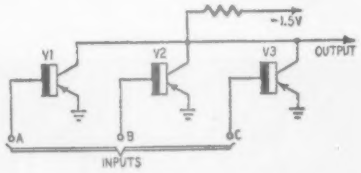


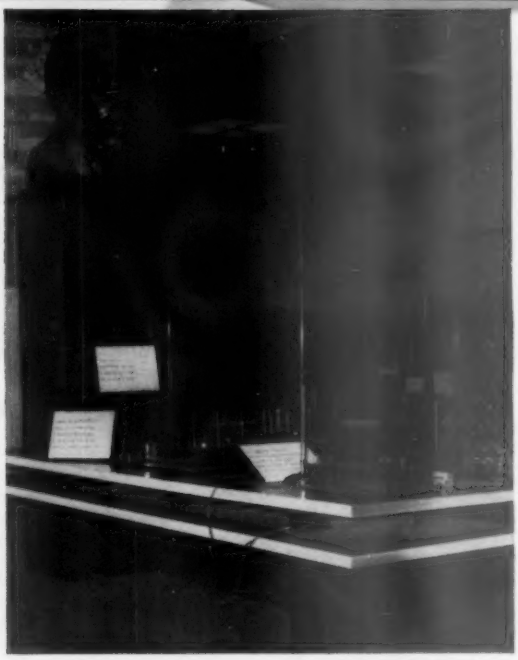
Fig. 4—*Or* circuit passes current when any one transistor conducts.

any base is grounded, that particular transistor blocks and prevents output. This diagram assumes a stage gain of 10. For example, 140 μa through the base of V3 corresponds to a flow of 1400 μa through its collector, and so on. There is a limit to the number of stages in the network, since there is a progressive decrease in current from one transistor to the next. In practice, up to five transistors may be connected.

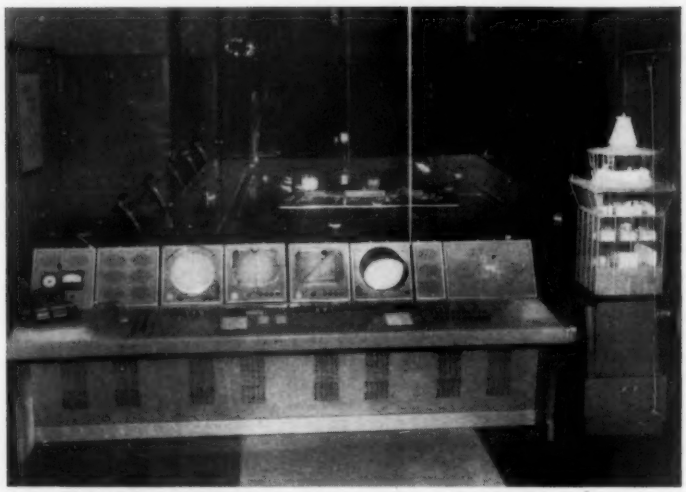
Fig. 4 is called an "*or*" circuit. Output may be obtained when any transistor, V1 *or* V2 *or* V3 conducts. Each must be capable of passing sufficient current to operate the load for the desired application. END

ЧТО НОВОГО*

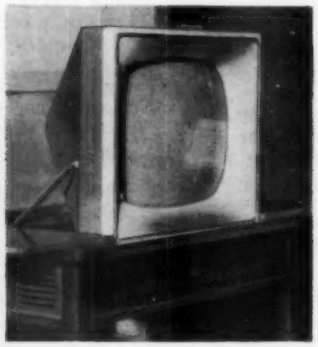
In July and August the U. S. S. R. held their Soviet Exhibition of Science, Technology and Culture at the Coliseum in New York City. Some of the electronic displays are shown here.



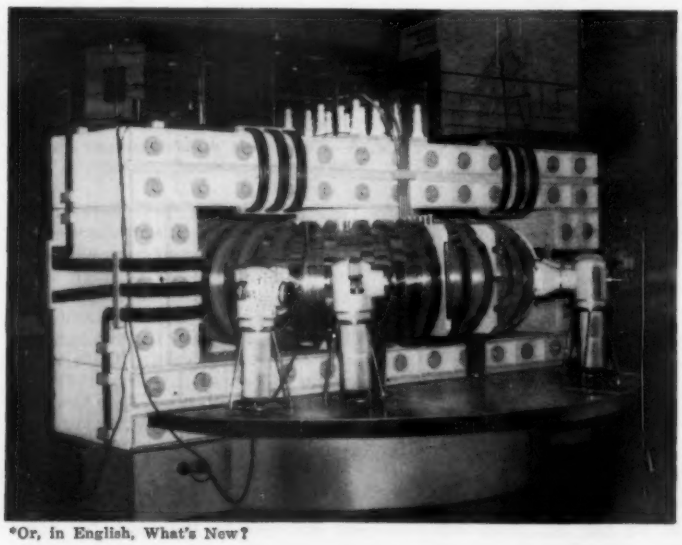
A. S. POPOV's bust looms over the exhibition from one of the most commanding positions in the hall, overlooking some of his early equipment and that of P. L. Shilling, another early worker in electrical communications. (Boris Rosing is celebrated in the television section.) Russia's pioneer of radio, Popov, established a station at Kronstadt in March, 1897, and in 1900 his equipment was used in what was possibly the first rescue at sea by radio, when the icebreaker Ermak was instructed by wireless to rescue a group of fishermen stranded on floe ice. For this and other reasons, Popov is described as "The Inventor of Radio" on the placard below. (Of course, RADIO-ELECTRONICS readers know that radio is an American invention, Dr. Loomis having taken out a patent on a radio communications system in 1872—while Popov was still in school—some 6 years after he had actually succeeded in transmitting a signal 14 miles. See RADIO-ELECTRONICS, April 1959, page 48.)



GCA RADAR SYSTEM designed to guide planes to safe landings and takeoffs at Russian airfields was the largest electronic display at the exhibition. Four radar indicators are used. The three to the left are TV screens with special scans, and give indications of the approaching plane's position in relation to the airfield, the runway and the glide path. (Computers, not shown, translate radar indications into TV images to get clear, easy-to-see traces.) Fourth indicator, an ordinary radar screen, shows the plane's distance from the field. Working model of airfield in background shows how planes land and take off, following control tower instructions. No statement was made as to whether such a system was in use or being constructed at any airport in the Soviet Union, or whether it was simply a design for the future.



FOLDAWAY TV RECEIVER keeps its chassis hidden from view in the ends of the table. When not in use, the picture tube is concealed inside the table too, and a chess board adorns the table top. The set features a "Shortnik" 110° picture tube.



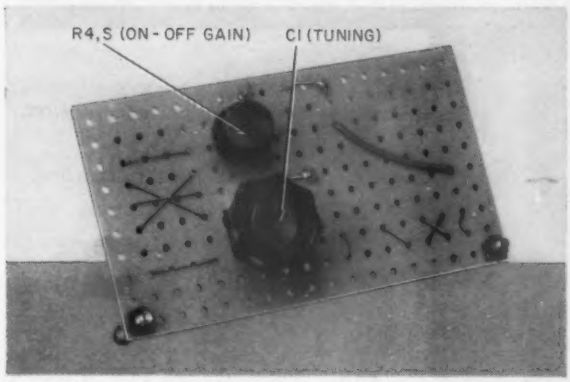
THERMONUCLEAR POWER PLANT uses plasma technique. This highly-heated (up to 10 times the temperature of the sun) gas (plasma) is contained in the torodial core in the center of the unit. Electric current fed through the spiral coil around the core heats the gas to the high temperatures at which atomic reaction may occur. The magnetic field introduced by current in the coil stabilizes the plasma, keeping it away from the sides of the chamber—it would melt the walls if it approached them. The Russians call their device a pulse transformer and have named it "Thermonuclear Installation Alpha."

*Or, in English, What's New?

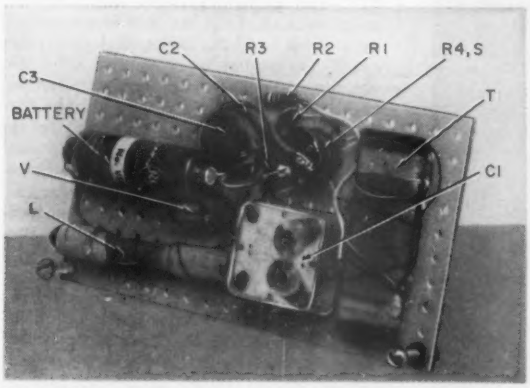
BROADCAST-BAND BOOSTER

Add sensitivity to your portable radio without making any physical connections between it and the booster

By I. QUEEN
EDITORIAL ASSOCIATE



Gain and tuning controls are on the front of the mounting board.



Everything mounts on a small sheet of perforated board. Note that L and T are perpendicular.

IS your portable radio inadequate when played in some locations? Do you like to stay up late listening to programs from distant cities? Would you like to extend the range of your portable? If the answer to any of these questions is yes, this booster may solve your problem. It is an rf stage coupled inductively to your radio to increase its gain tremendously. *No wired connections are made between the units.*

To use the booster, tune your radio to the desired station and adjust for maximum output. Place the booster output coil L near the radio's antenna and tune the booster for maximum signal. Advance the booster's GAIN control as required. Stations normally at whisper strength will come up to full local level. Very often stations that are *inaudible* with the radio alone are brought in loud and clear with the booster added!

The circuit is very simple. See the diagram and photographs. T is the booster's antenna. L is the output coil mounted at right angles to T. The output coil is untuned so no neutralization is needed. I removed 10 turns from it to make sure that it would not resonate in the broadcast band. Note that the *collector end* of this coil is mounted near the transistor and a *short lead* connects the two parts.

L and T are tied to the perforated baseboard with heavy thread.

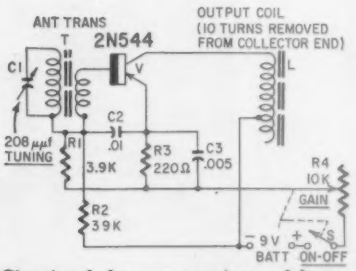
L acts as primary of a transformer, its secondary being the radio ferrite antenna to which it is coupled.

The antenna transformer covers the entire broadcast band when connected to the antenna section of a two-gang variable capacitor (see parts list).

A major requirement is that the radio antenna coil be accessible for close coupling to L. This is true of most portable transistor sets. Results are better when L is at right angles or coaxial with either end of the radio's antenna. But experiment to determine relative distances and positions for these units. Of course, T may be oriented for maximum pickup from the desired station.

If oscillations occur with R4 turned up all the way, readjust it until they just cease. This is the most sensitive setting. If no oscillations occur, the resistance may be reduced to zero for maximum gain. Battery drain is approximately 1 ma.

END



Circuit of the one-transistor rf booster.

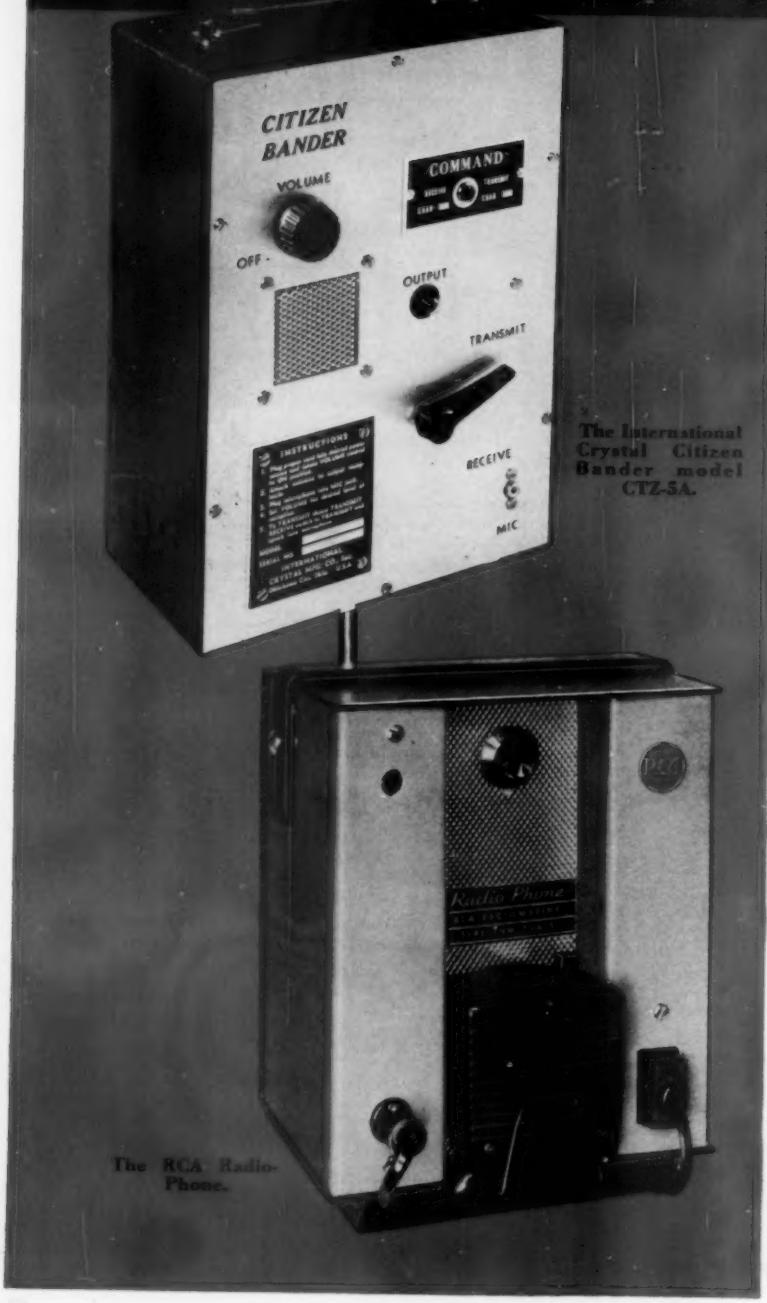
R1—3,900 ohms
R2—39,000 ohms
R3—220 ohms
R4—pot, 10,000 ohms, with spst switch (Lafayette VC-28 or equivalent)
All fixed resistors are ½-watt 10%
C1—208-μμf variable capacitor (Antenna section of Lafayette MS-270)
C2—.01 μf
C3—.005 μf
BATT—9 volts
T—ferrite-core antenna transformer (Lafayette MS-329 or equivalent)
L—ferrite core antenna coil (Lafayette MS-272 or equivalent)
V—2N544
Mounting board, 2¾ x 4¾ inches
Battery holder
Miscellaneous hardware

BENCH TESTED

Unit was tested with both transistor and vacuum-tube receivers. In all cases sensitivity of the receiver was markedly improved. Stations that were just barely above the noise level came in loud and clear. Some stations that could not even be heard before the booster was turned on, also came in clearly.

One inherent difficulty—the booster cannot be used with some old radios that have a loop antenna. Some type of ferrite core antenna must be in the receiver. Otherwise coupling between the booster and the receiver is too poor to permit the booster to do its job.

CITIZENS' BAND RADIOS ...how they work



The International Crystal Citizen Bander model CTZ-5A.

The RCA Radio-Phone.

Some fundamental information, plus a close look at two 11-meter units with a detailed discussion of their circuits

By ROBERT F. SCOTT
TECHNICAL EDITOR

LAST September, the FCC withdrew the 11-meter band (26.960 to 27.230 mc) from Amateur use and assigned it to the Citizens radio service. This move was prompted by a great need for additional spectrum space for radiotelephone use by individuals, corporations and partnerships and particularly those not eligible for licenses in the Land Transportation or Industrial radio services. There was also a need for additional frequencies for radio control of models, garage-door openers and similar devices and for actuating signals and devices for attracting attention.

This new 11-meter Citizens band is for use by class-C and class-D stations. No tests or examinations are required but authorization to operate must be obtained from the FCC. Class-C licenses are for remote control using tone modulation or on–off unmodulated carrier on 26.955, 27.045, 27.095, 27.145, 27.195 and 27.255 mc. Maximum power input to the plate of the stage feeding the antenna is 30 watts on 27.255 mc and 5 watts on the other five class-C frequencies. Licensees of class-C stations must be at least 12 years old.

The class-D section of the Citizens radio service is of the greatest interest to the general public since its uses are practically endless. Its purpose is to provide private short-range radiotelephone communications. Sportsmen can use this band to maintain contact with each other in the field or with a base camp. Farmers, contractors, deliverymen and small business firms may use the band for maintaining contact between office and equipment. A husband, driving home from the office, can call his wife by radiotelephone and tell her

when to put on the steaks or can report delays in traffic. Applicants must be at least 18 years old to be eligible for a license on this band.

Class-D Citizens radio stations are mobile[1] AM radiotelephone only, operating with a maximum power input of 5 watts to the final amplifier. Tone modulation may be used as an aid to establishing and maintaining contact between stations. They have available 22 channels averaging 10 kc apart between 26.965 and 27.225 mc. The table shows the channel numbers and their corresponding frequencies.

The effective range of transceivers for class-D operation depends on the height and types of antennas used at the receiving and transmitting locations and on interference conditions. Generally, the maximum range is 15 to 20 miles. Mobiles cover 1 to 3 miles in cities, up to 10 miles in open country and up to 15 miles over water. When operating base to mobile or base to base the coverage often increases because of higher and more efficient antennas at the base stations.

Transceiver circuits

Transceivers in class-D service range from 4 to 10 tubes or more with one or more being used in circuits common to the transmitter and receiver sections. For example, tubes in the speech amplifier and modulator circuits of the transmitter are frequently used in the receiver between the output of the detector and the speaker.

The receiver sections in transceivers vary from simple rf amplifier and superregenerative detectors to elaborate dual-conversion superhets with such features as automatic noise limiters or clippers to squelch circuits.

Transmitter rf circuits are generally just what we would expect to find in use on the Amateur bands. They are all crystal-controlled and range from the simple modulated oscillator in the RCA transceiver described in this article to multi-tube rigs with oscillator, frequency multiplier and modulated final amplifier.

The Citizen Bander

First let's look at a comparatively complex unit, the CTZ-5A Citizen Bander transceiver made by International Crystal Manufacturing Co. and available in three models that vary in receiver and power supply circuitry. The Custom operates from 117 volts ac only and its receiver has continuous tuning from 26.9 to 27.3 mc. The Deluxe has the same receiver and a three-way power supply operating from 6 or 12 volts dc and 117 volts ac simply by changing the power input cable. The Command has a three-way power supply and a crystal-controlled receiver for reception on a single channel. All receivers are double-conversion types with avc and automatic noise clippers. Late models have a built-in squelch. Squelch kits are available for early-production models.

[1] This definition includes hand- and pack-carried units. Class-C and D Citizens radio stations are authorized as mobile stations only but the FCC rules provide for operations in fixed locations.

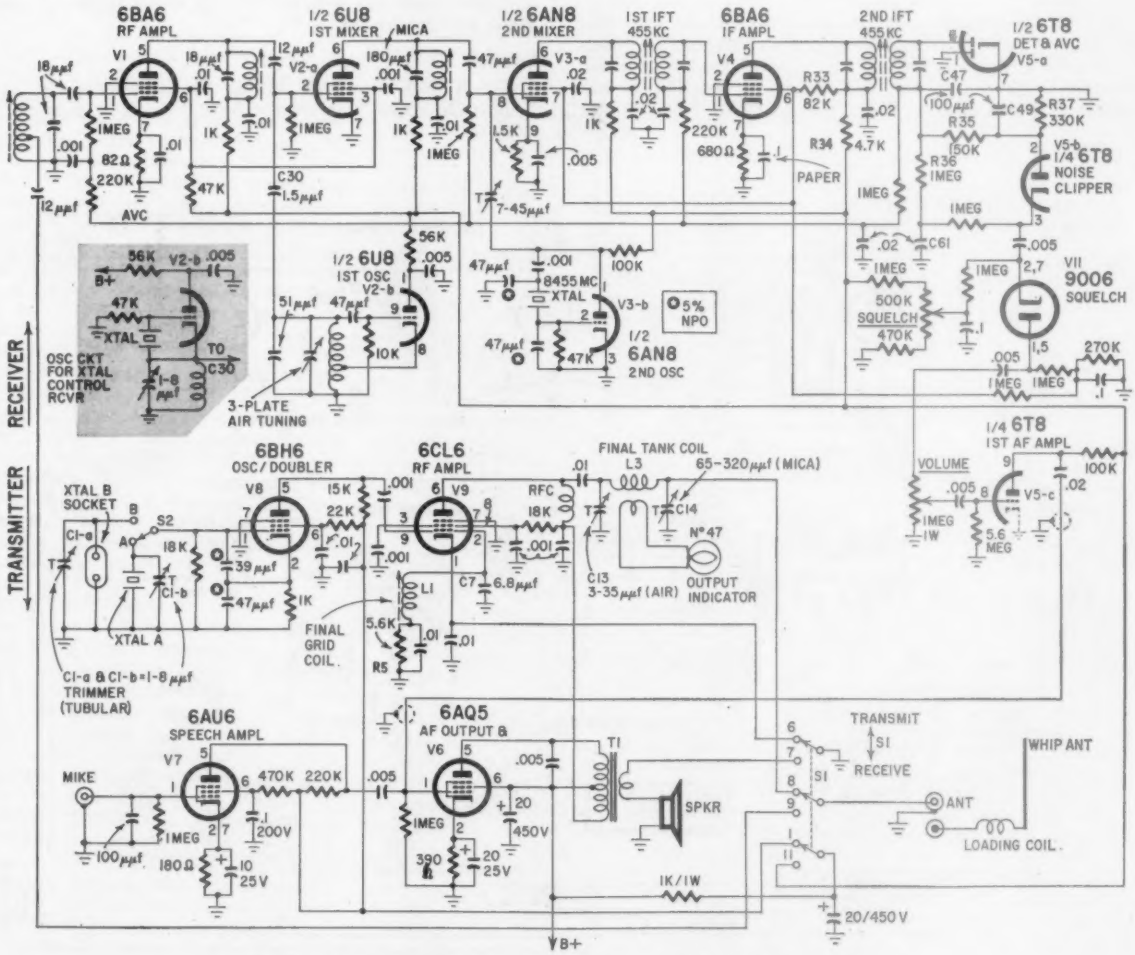


Fig. 1—Circuit of the International Crystal CTZ-5A2 transceiver.

The transmitters are crystal-controlled with frequency tolerance of ±.005% and 5 watts input. Early-production models have a single transmitting crystal. Later units have a socket and switch for a second crystal and a greatly simplified send–receive switching system that permits remote push-to-talk operation by adding a three-pole double-throw relay.

The circuits of the CT-5A-2 transmitter and CTR-5A-2 receiver are shown in Fig. 1. The receiver is a six-tube double superhet with an 8-mc first if to eliminate image interference, and a 455-kc second if to provide adequate selectivity. The antenna is coupled to the antenna coil in the grid circuit of the 6BA6 rf amplifier with S1 in the RECEIVE position. The rf amplifier grid and plate coils are broad-banded and tuned to 27.1 mc in receivers with variable tuning and are peaked to the desired channel in single-channel models.

The 6U8 is the first mixer and oscillator. The oscillator operates 8 mc above the channel frequency and develops an 8-mc signal in the first if coil. The circuit of the crystal-controlled oscillator is circled with dashed lines. The crystal is a third-overtone type.

The 8-mc first-if signal is fed to the grid of the 6AN8 second mixer where it beats with the 8.455-mc signal from the second oscillator to produce the 455-kc second if in the first if transformer. V4 is the 455-kc if amplifier feeding the 6T8 detector, avc diode, series-gate noise clipper and first af amplifier.

V5-a is the detector and avc diode. Audio and avc voltages are developed across R35 and R37 with C47 and C49 as rf filters. A negative voltage proportional to carrier strength is developed across C61 and is applied to the cathode of noise clipper V5-b. R36 and C61 have a long time constant so V5-b's cathode voltage remains relatively constant. V5-b's plate is connected to a point on the detector load where the voltage is approximately 70% of that on the cathode. Thus, V5-b's plate is positive with respect to the cathode so the tube conducts and the audio signal appears on the cathode. Noise spikes or pulses that exceed the maximum carrier modulation level drive the plate negative with respect to cathode and instantaneously cut off V5-b.

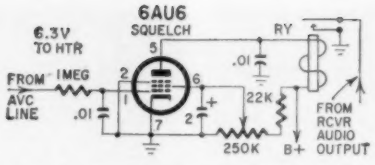


Fig. 2—Circuit of the CTZ-K1 squelch kit.

The squelch tube (V11) is a 9006 diode in series with the audio signal path between the cathode of V5-b and the grid of V5-c. The af signal is applied to V11's cathode through a .005-μf capacitor and is taken off the plate through .005 μf. The plate of V11 is biased positive by a voltage that varies with signal strength. This voltage is taken from the screens of V3-a and V4 and is determined by the current drawn through R34 and R33. When there is no signal strong enough to develop appreciable avc voltage, V3-a and V4 draw maximum and develop a large voltage drop across the resistors. The SQUELCH control is initially adjusted so V11's cathode is more positive than the plate so the tube cuts off and silences the receiver.

When a signal comes in, avc biases back V3-a and V4, reducing the drop across R33 and R34 and causing V11's plate voltage to rise. When the plate is more positive than the cathode, the tube conducts and feeds the detected audio signal to the af amplifier. The output of the first af amplifier feeds the grid of V6, the combination af output stage and modulator.

Squelch kit

The CTZ-K1 squelch kit is an accessory for early-production units that do not have a built-in squelch. The

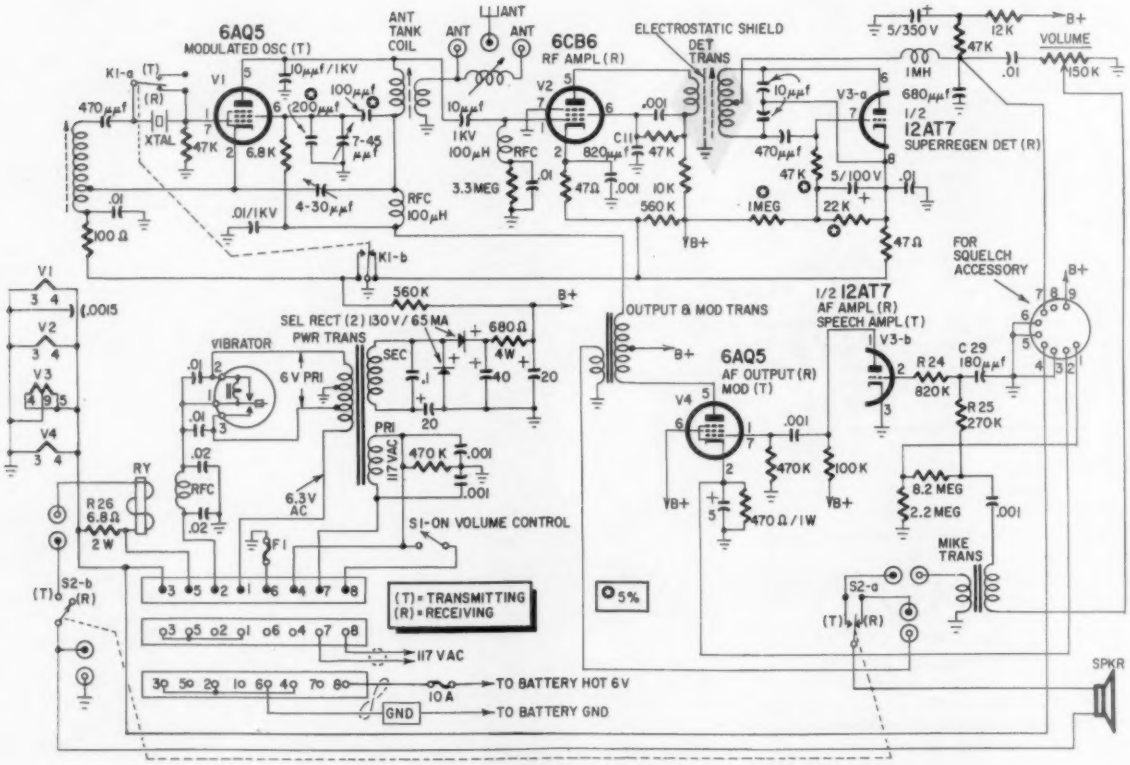


Fig. 3—RCA's Radio-Phone for the Citizen's band.

circuit is in Fig. 2. It is a 6AU6 ave amplifier with a muting relay in its plate circuit. The relay armature connects to the af output line from the receiver's af amplifier (V5). In the absence of a signal, the 6AU6 conducts and closes the relay to short the audio signal to ground. When a signal comes in, the ave voltage cuts off the 6AU6 and the relay opens and allows the signal to pass through to the af output stage. A potentiometer in the screen circuit sets the squelch threshold.

The transmitter

The 6BH6 oscillator–doubler uses a fundamental type crystal ranging from 13.4825 mc on channel 1 (26.965 mc) to 13.6125 mc on channel 22 (27.225 mc). Switch S2, accessible through a slot in the rear of the unit, selects the desired transmitting channel. Trimmers C1-a and C1-b zero the crystals to the frequency.

V8's plate is tuned to the second harmonic of the crystal frequency by L1-C7. Rf amplifier V9 is a straight-through class-C modulated amplifier biased by grid current flowing through R5. The rf output circuit is a shunt-fed pi network (C13–L3–C14) working into a 50–75-ohm unbalanced line.

When the TRANSMIT-RECEIVE switch (S1) is on TRANSMIT, the antenna is coupled to the output of the transmitter, and B-plus is removed from the receiver and applied to the plates and screens of the oscillator–doubler and the speech amplifier. The rf amplifier cathode is grounded and its plate and screen voltages are applied through half the primary of T1, the modulation and af output transformer. The signal from the microphone, amplified by V7 and V6, modulates the plate and screen currents of the rf amplifier flowing through T1.

When receiving, one section of S1 opens the cathode circuit of rf amplifier V9 and completes the voice-coil circuit to the speaker. The second section switches the antenna from the transmitter to the receiver's input, and the last section applies B-plus to the receiver and breaks the circuit to the transmitter's oscillator–doubler and speech amplifier.

RCA Radio-Phone

The RCA unit is a bit simpler. Their model CRM-P2A-5 Radio-Phone is a 5-watt unit available in two versions. One is for 117-volt 60-cycle ac and 6 volts dc and the other for 117 volts ac and 12 volts dc. It is a single-channel unit with a crystal-controlled modulated transmitting oscillator and a receiver section consisting of an rf amplifier followed by a superregenerative detector. Audio squelch is provided as an accessory. A small PM type transducer with a push-to-talk button is used as both microphone and speaker. When not in use, it fits into a clip on the instrument's front panel. The circuit of the 6-volt version of the Radio-Phone is shown in Fig. 3.

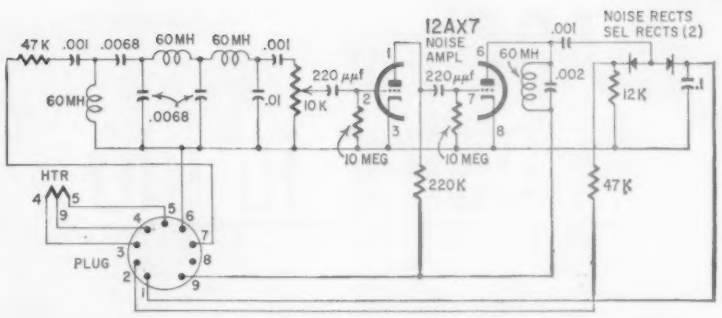


Fig. 4—Squelch circuit used in the Radio-Phone.

The diagram shows the circuit with the control relay (K1) in the unenergized (receive) position. The cathodes of V2 and V3-a are grounded by contacts K1-b of the send–receive relay. Contacts K1-a short out the crystal to prevent spurious responses in the receiver. Oscillator V1 is biased to cutoff by the high B-plus voltage applied to its cathode.

For those who prefer to build their own, RADIO-ELECTRONICS plans to publish a complete constructional article on a Citizens radio as soon as we have a good, debugged job ready to present. Several designs—including a coat-pocket transistor model—are being tested by our staff and an independent radio engineering laboratory. When we publish a how-to-do-it article on Citizens radio, you can construct the equipment with assurance that it will meet FCC specifications on frequency tolerance, modulation percentage, harmonic attenuation and bandwidth of emission.

The grid of rf amplifier V2 is coupled to the antenna tank coil through a 10-$\mu\mu$f capacitor. The 6CB6 amplifies the incoming signal and feeds it to the detector. The amplifier is neutralized by the combined screen and plate bypass capacitor C11 to reduce radiation from the superregenerative detector.

Detector V3-a is half of a 12AT7 in a Colpitts oscillator circuit. The af signal is developed across the volume control and is fed through the secondary of the microphone transformer to the grid of V3-b, the first af amplifier. The high-pass filter consisting of R24, R25 and C29 removes the quench frequency and limits the frequency response to the range providing the most intelligible communications.

V3-b's plate is R-C-coupled to the grid of V4, a 6AQ5 power amplifier operating as the af output stage when receiving and as the modulator when transmitting. The mike–speaker unit is connected across the secondary of the output and modulation transformer through the contacts of push-to-talk switch S2-a.

When S2 is pressed to transmit, S2-a switches the PM unit across the primary of the microphone transformer and S2-b completes the circuit through the relay coil. Contacts K1-a open to remove the short from across the transmitting crystal and K1-b switches the ground from the receiver cathodes to the cathode of V1, the transmitting oscillator.

The power supply uses a voltage doubler to obtain approximately 250 volts B plus. When operating on dc, the vibrator is across the center-tapped portion of the low-voltage winding, and the vibrator armature and heater line are connected to the hot side of the battery. Fuse F1 is a short length of No. 28 wire to protect the supply against incorrect dc polarity. It blows if the lead marked "ground" is accidentally connected to the hot side of the battery and the case or antenna is grounded. This does not disable the unit for ac operation.

During ac operation, line voltage is applied to the 117-volt primary of the power transformer. The ac cable connector shorts out resistor R26 in series with the relay coil so it draws enough current to operate.

CLASS-D CITIZENS' BAND CHANNELS AND FREQUENCIES

Channel	Mc	Channel	Mc
1	26.965	12	27.105
2	26.975	13	27.115
3	26.985	14	27.125
4	27.005	15	27.135
5	27.015	16	27.155
6	27.025	17	27.165
7	27.035	18	27.175
8	27.055	19	27.185
9	27.065	20	27.205
10	27.075	21	27.215
11	27.085	22	27.225

Fig. 4 is the circuit of the accessory squelch used with the Radio-Phone. This circuit operates on the hiss that comes from a superregenerative detector when no signal is being received. The detector output is tapped off just ahead of the volume control and applied through a 47,000-ohm isolation resistor to an L-C type bandpass filter that eliminates voice and squelch frequencies and passes hiss and noise in the range of 10 to 12 kc. This noise is amplified by the 12AX7 and then fed to a selenium rectifier voltage doubler to develop at least 20 volts negative. This voltage is applied to the grid of V3-b in the receiver to bias it to cutoff. When a signal comes in, the noise cuts out and bias is removed from V3-b's grid so that it amplifies. END

ABC's of MOBILE RADIO

Part VIII — More about base stations — radio-link remote control, antennas, transmission lines, relay stations and Conelrad

By LEO G. SANDS*

LAST month we examined receivers, transmitters and power supplies used for mobile-radio base stations. We also examined remote control via telephone line. This month we continue our base station survey.

In areas where leased telephone lines are not available for remote-control purposes, a radio link may be used. The operating band depends upon which bands the licensee is eligible for.

The 72–76-mc band can be used by those who are eligible for licensing in that band and where the system is away from areas where TV channels 4 and 5 are in use. Several manufacturers make equipment for this band.

The 450–470 mc band and the 900–mc Citizens band are widely used for radio control link operation because of the far fewer restrictions and much broader licensing eligibility.

Regardless of the band, operating techniques are the same. Fig. 1 is a block diagram of a base station controlled via radio link. Under standby conditions, receivers A, B and C are operative, but muted by their squelch circuits. When a signal from a mobile unit is intercepted by receiver A, the carrier-operated relay energizes transmitter B. Receiver C picks up the signal from transmitter B, which rebroadcasts the intelligence intercepted by receiver A.

When the signal from the mobile unit ceases, transmitter B shuts off automatically because of the action of the carrier-operated relay of receiver A, restoring the entire system to standby.

*Author, *Guide to Mobile Radio* (Gernsback Library).

In initiating a call at the control point, the press-to-talk switch is operated, activating transmitter C. The signal is picked up by receiver B whose carrier-operated relay activates transmitter A. Transmitter C's audio signal is rebroadcast by transmitter A to the mobile units.

Generally, antenna A is omnidirectional since mobile units may be in any direction from the base station. While antennas B and C may also be omnidirectional types, unidirectional antennas are preferable. By using unidirectional antennas, the signal can be concentrated into a beam, reducing possible interference to others and providing more reliable transmission between the control point and base station.

Some receivers have a squelch circuit in which a relay opens and closes the audio circuit. These relays can generally be equipped with extra contacts for control purposes. Most, however, employ what is known as *electronic squelch*. To control a transmitter in response to squelch action, a relay is required. Generally, this is part of an external device, the *carrier-operated* relay.

Typical is the RCA MI-31690 carrier-operated relay panel. Actuation of the relay depends upon two conditions, the reduction of noise which occurs when a signal is received, and sufficient dc voltage at the grid return of the second limiter stage, a condition which also depends upon the presence of a signal. By relying on this combination, the circuit becomes fail-safe, eliminating the possibility of false operation due to receiver desensitization or failure.

This control device, which can be used with any FM receiver, has one pair of normally open relay contacts for control of a transmitter. When more contacts are required, an interposing relay may be used, controlled by the relay in the unit.

It is a good idea to provide some sort of time-controlled disabling device to shut off the base station and control-link transmitters (A and B) if stuck relay contacts or some other malfunction should cause either transmitter to remain locked on. Various timers for this purpose are available.

The control-link equipment may consist of a pair of 450-mc-band base-station units, one comprising transmitter B and receiver B, and the other transmitter C and receiver C.

A microwave link may be used, but the cost of a 900-, 2,000- or 6,000-mc-band microwave system is considerably greater than that of a pair of 450-mc-band units. However, when several functions are to be controlled, a microwave link may be required. It can be used to transmit one or more audio channels as well as several tone channels, each of which can be used for control of apparatus.

Control possibilities are actually extensive enough to warrant writing a complete book on the subject and hence can be treated only lightly here.

Antenna systems

Base-station antenna systems is another broad subject which would require several pages to cover in detail.

The antenna system is perhaps the most important major component of a base station. It, more than anything

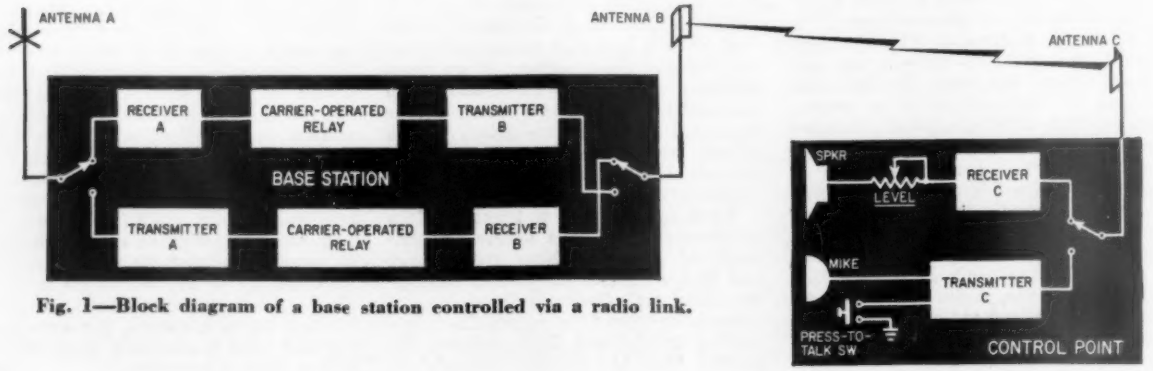


Fig. 1—Block diagram of a base station controlled via a radio link.

Ceco control unit for a base station resembles a telephone. Includes built-in speaker and transmitter monitoring lamp.

Base station with 250-watt transmitter, made by Motorola, is designed for 450–470-mc operation.

else, governs performance. It determines useful receiver sensitivity and the effectiveness of the radiated signal. With a proper antenna system, a walkie-talkie can be as effective as a high-power base-station communications unit used with a poor antenna system.

The effective radiated power of a transmitter can be increased by an efficient antenna system without raising the transmitter's input power requirements. Thus, more effective watts can be obtained without having to pay more on a continuing basis for additional utility power.

Loosely speaking, the higher the antenna is above the ground, the greater the range. However, this is not always true. Optimum performance is sometimes obtained at a specific antenna elevation.

If the antenna is high off the ground, the transmission line may have to be so long that excessive power losses will occur. This can be counteracted by using a transmission line which introduces lower losses, but at greater cost.

Antenna supports

There is a happy compromise, usually. When a 100-foot antenna support can provide the required range, there is no point in using a 200-foot antenna support which may increase the range sufficiently to cause interference to another system operating on the same frequency in another community.

There is a wide choice of towers for use as antenna supports. Where a 60- to 80-foot support will suffice, an unguyed telephone pole can be used. Generally, a power company or a telephone company will furnish and set a pole for a nominal fee. Steps can be installed so the antenna and transmission line can be serviced.

It is a good idea to keep the antenna support under 150 feet in height and away from airport areas so that expensive tower lighting will not be required.

Omnidirectional antennas

A wide choice of antennas with omnidirectional radiation patterns is avail-

Ameco CD-1 Conelrad monitor is an attachment for standard AM broadcast receivers.

Kaar 117R224 base-station receiver for medium-frequency mobile radio applications.

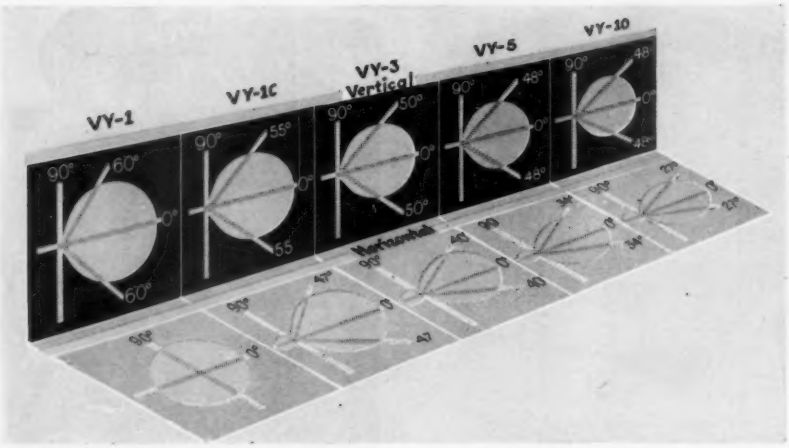


Fig. 2—Radiation patterns of ground-plane.

able from several manufacturers. Some types provide power gain by concentrating radiation close to the earth's surface.

Among the antennas which offer little or no gain (or even a slight loss) are the coaxial and ground plane types. Among those which offer power gain is the Andrew type 3000 for the 148–174-mc range with a gain of 6 db. It effectively quadruples the effective radiated power. The Andrew 4000 antenna for the 450–470-mc band provides a gain of 7.6 db.

Directional antennas

In some systems it is advantageous to concentrate the signal in certain directions, minimizing radiation in others. Here, again, the system planner has a wide choice.

Tele-Beam Industries, for example, has developed a line of communications antenas which can be assembled in the field in many different configurations. Standard components which include radiating elements, reflectors and directors and complementing hardware are available.

For example, the Tele-Beam gamma-matched coaxial ground-plane antenna can be converted into a cardioid-pattern antenna by adding a single element. Still another element can be added to form a three-element, vertically polarized, unidirectional Yagi array.

Fig. 2 shows the horizontal (bottom) radiation patterns and the vertical radiation (top) patterns of various Tele-Beam antennas. The VY-1 is a coaxial ground-plane type; a VY-1C is the same antenna with an element added to obtain a cardioid pattern. The VY-3 is the same basic antenna converted into a three-element Yagi. The VY-5 is a five-element Yagi and the VY-10 consists of two five-element Yagi arrays ganged horizontally (side by side) to provide 11-db gain in a forward direction.

High-gain directional antennas are available for the 25–50-, 152–162- and 450–470-mc bands as well as other frequencies within this spread. Most antenna manufacturers publish comprehensive catalogs from which the system planner may make a selection. Besides gain, other factors to consider are weight, size, durability and ability to withstand anticipated environmental conditions.

Transmission lines

The base-station antenna is connected to the base-station transmitter and receiver through a coaxial cable (generally 50 ohms) which has a solid dielectric between the inner conductor and outer shield, or dry air or a gas under pressure.

For a short run, standard RG-8/U (50-ohm) coaxial cable is often used. For longer runs, lower-loss RG-17/U coaxial cable is popular. Solid-dielectric coaxial cable is easier to use and generally less expensive than the hollow-line types which must be pressurized.

However, the use of low-loss hollow transmission line, even at higher initial cost, is often justified by the improved performance. As a rule of thumb, consider solid-dielectric cable for short and medium runs and hollow line for long runs. The choice can be made by comparing specifications and evaluating range and environmental requirements.

Relay stations

A *relay* station is similar to a base station except that its operation is controlled by a radio signal, and the transmitter and receiver operate simultaneously instead of sequentially. It intercepts intelligence from one station and relays it to another. A relay station is sometimes used to extend the mobile-to-mobile communicating range by routing communications through it, taking advantage of its greater antenna elevation.

Fig. 3 is a block diagram of a relay station. A signal on one frequency (f1) intercepted by the receiver actuates the carrier-operated relay which turns on the transmitter. The receiver audio output is fed to the transmitter audio input which rebroadcasts on another frequency (f2).

The receiver and transmitter may be separated by several hundred feet with a wire line to interconnect them. This permits separating the transmitting and receiving antennas to reduce loss of receiver sensitivity due to close proximity to the transmitter, which is more severe when there is only a small difference between the two frequencies.

Often, however, the transmitter and receiver are in the same room. When the two antennas must be close together for economic reasons or lack of space, a cavity is sometimes inserted in the receiver antenna system to attenuate the signal from the transmitting antenna. The cavity is in essence a high-Q wavetrap.

As mentioned earlier, using a timer to prevent unwanted operation of the transmitter is recommended. Some relay stations are equipped with lockout devices which prevent actuating the station except when a tone or other coded information is intercepted with the signal.

Satellite stations

Where one base station will not cover the required area, two or more stations are sometimes employed. They can be activated simultaneously for blanket coverage or selectively for covering certain areas only.

Sometimes a single base station is used, employing a high-power transmitter which blankets the area. Satellite receivers, whose audio output is fed to the control point over wire lines, are

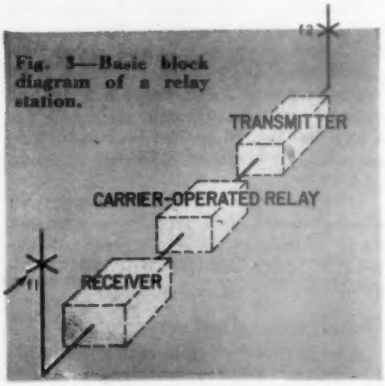


Fig. 3—Basic block diagram of a relay station.

the UNIDIRECTIONAL DIPOLE

By LEONARD E. GEISLER

ANYONE who has peeked inside one of the many radio handbooks is familiar with the figure-8 radiation pattern of the dipole (or doublet) antenna. However, most readers probably are not aware that you can make a highly directional, broad-band antenna from the simple dipole without resorting to additional elements—other than one resistor, some TV standoff insulators, spars and a little labor.

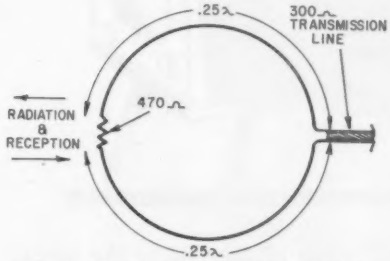


Fig 1—Basic unidirectional dipole.

By simply bending the conventional dipole into a perfect circle and joining the two ends opposite the feed point with a noninductive resistor, the antenna becomes unidirectional (Fig. 1). Radiation and reception take place only on one side of the loop—the one terminated by the resistor.

To build such a dipole, say for 6-meter ham-band operation first find the length of a half-wave (0.5 λ) radiator for the low side of the band. This would be approximately 110 inches long. Since the antenna is bent into a circle with a 110-inch circumference, we insert this value in the formula:

$$\frac{C}{3.14} = D$$

where C is the circumference, 3.14 is pi (approximately) and D diameter or, in this case, length of the cross-piece with the installed length of TV standoff insulators subtracted. Assembly details are shown in Fig. 2.

After the cross-shaped support is assembled, proceed to thread two 55-inch lengths of radiator through the eyes of the TV standoffs. Unless quite stiff, large-diameter wire or tubing is used, be careful and preserve the circular shape. Use aluminum clothes line, No. 10 enameled copper wire or ¼-inch copper tubing for optimum results.

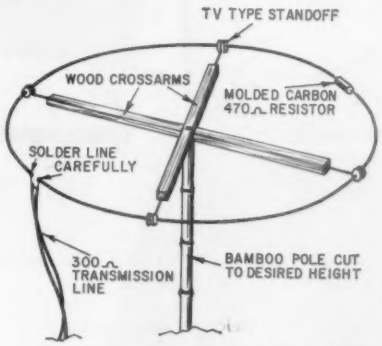
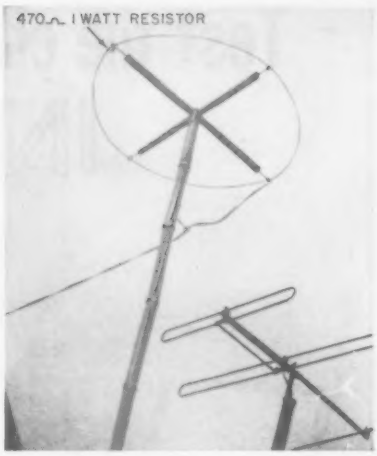


Fig. 2—A practical unidirectional dipole.

Fasten the completed loop assembly to a bamboo or wood mast and bring the 300-ohm ribbon line down as nearly at right angles to the antenna as possible. Avoid placing undue strain on the antenna proper. Aim the side opposite the feeders in the direction you wish to receive from (or transmit to) and you're on the air!

Simple, isn't it?

Of course, this antenna is cut for the low edge of the 6-meter band. However, its excellent front-to-back ratio (5 to 1 approximately) will hold good far above that frequency. By a minor error, we designed and constructed a similar 108-mc antenna—learning about 3 weeks later that we had cut it for just *half* that frequency—and during the entire 3-week period had such phenomenal reception that we told all our friends about it. Only after the error in our arithmetic was pointed out did we realize just how broad-band the antenna was!



Because of this error, we decided to test the antenna carefully. We found that it would actually operate with little or no change in front-to-back ratio until we reached the third-harmonic mode of operation, where the antenna's gain actually increased while beam angle was reduced only by a small amount. Our conclusion was that the unidirectional dipole was the job we needed.

If you wish, several similar units may be stacked vertically, 0.5 λ apart, along the same mast and fed in parallel. This improves the front-to-back ratio and beam angle, along with a proportional increase in gain. Frequency sensitivity changes very little. The value of the terminating resistors has to be increased in proportion to the number of elements used for proper transmission-line termination.

By spacing two of these antenna elements one or more wavelengths apart—vertically—and connecting them to a common feeder via a transmission-line hybrid, excellent space diversity reception and transmission may be enjoyed. By using this system we have found that gains of the order of 10 db or more are common over long-haul dx routes.

If you use the unidirectional dipole with a transmitter, the terminating resistors must have a wattage rating high enough to prevent burnout. A good safe value is 10% more than the *input* power to your final amplifier.

(A portion of the material presented here was obtained from "Technical Notebook" in Wireless World, October, 1957.)

END

ABC's of mobile radio *(Continued)*

used to pick up signals from mobile units. The satellite receivers are installed at strategic locations.

Conelrad

FCC rules dictate that every radio station be equipped with means for intercepting Conelrad alerts. Operation of a transmitter during an alert could aid an enemy navigate aircraft or home a missile.

An ordinary AM broadcast receiver or a TV set can be used for receiving alerts. However, it is seldom practical for a base-station operator to monitor a broadcasting station continuously while doing his work. Therefore, several manufacturers, including RCA, DuMont, Motorola and Kaar, build special receivers which monitor a broadcasting station *silently*, actuating an alarm in case of a Conelrad alert. Other manufacturers build outboard attachments which are connected to standard AM receivers and which also actuate an alarm when an alert is intercepted.

A standard piece of apparatus for all base stations is a Conelrad monitor which will warn the operator not to transmit during an alert.

Summary

The base station is the nerve center of a mobile radio network. Its operator is responsible for the proper working of the whole system. The location and the antenna system of the base station determine, to a great extent, the effective base-to-mobile and mobile-to-base communicating range. Therefore, the system planner should give prime consideration to the base station, carefully evaluating such factors as location, antenna, power reliability and availability, remote-control problems and access for maintenance. END

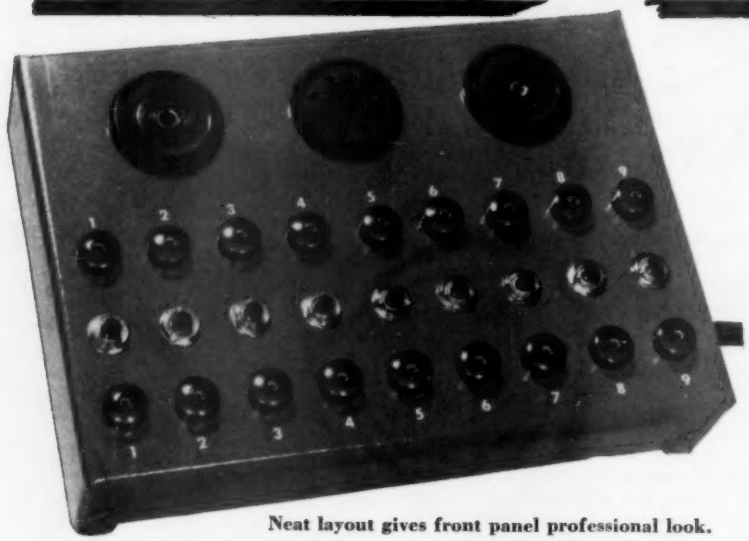
Test the chassis IN THE CABINET

Simple adapter helps the technician avoid pulling a chassis unless it's really necessary

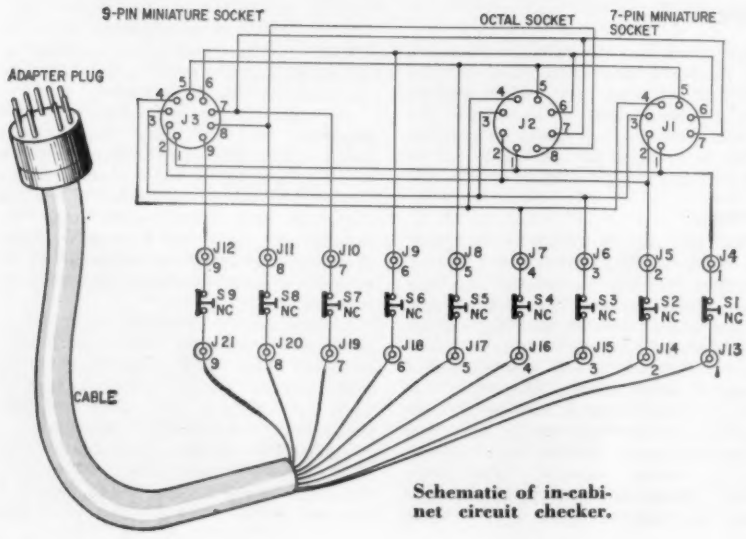
By R. L. WINKLEPLECK

TIME is the most valuable item the radio–TV service technician has to sell. His financial success or failure hinges on how well he can reduce service time per set to the absolute minimum consistent with a good job and customer satisfaction. Therefore, when a set can be serviced without wasting time removing a chassis from its cabinet and subsequently replacing it, he's dollars ahead.

Manufacturers of servicing equipment have recognized this and have made it possible to take voltage, resistance and (in some circuits) waveform tests from above the chassis through the use of test-socket adapters. These units, with their test contacts, are inserted between the tube socket and the tube and are great time savers. Naturally, the results of the above-chassis tests sometimes dictate chassis removal from the cabinet, but many

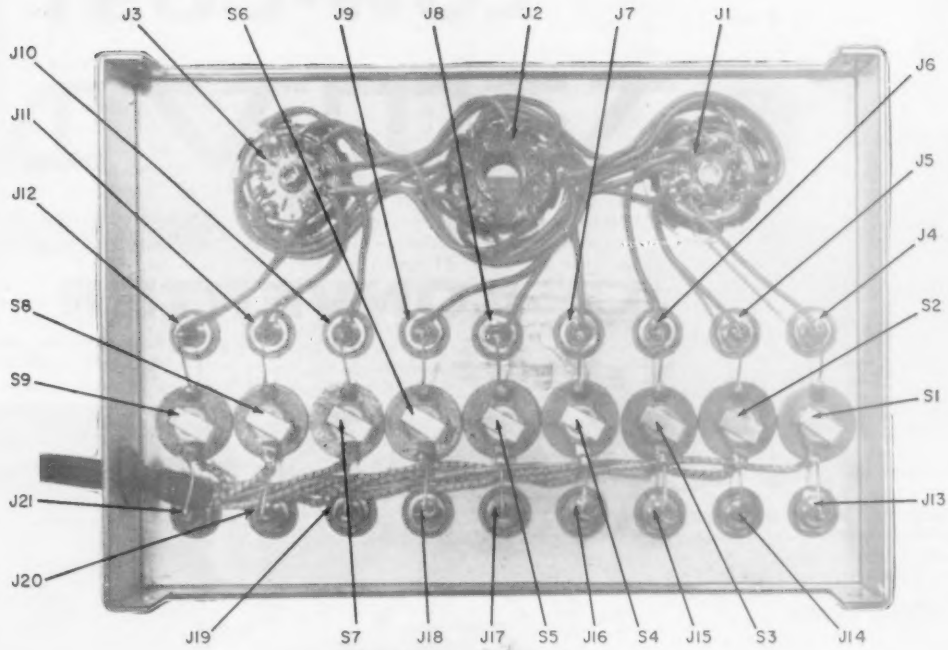


Neat layout gives front panel professional look.



Schematic of in-cabinet circuit checker.

J1—tube socket, 7-pin miniature
J2—tube socket, octal
J3—tube socket, 9-pin miniature
J4–J21—tip jacks, insulated
S1–S9—push button switch, spst, normally closed
Octal male cable connector (Ampheonol 86-PM8 or equivalent) (for octal adapter)
Tube socket, 9-pin miniature (for octal adapter)
9-pin cable plug (Vector P9D or equivalent) (for 9-pin miniature adapter)
Tube socket, 9-pin miniature (for 9-pin miniature adapter)
7-pin cable plug (Vector P7A or equivalent) (for 7-pin miniature adapter)
Tube socket, 9-pin miniature (for 7-pin miniature adapter)
Chassis box, 7 x 5 x 3 inches (cut down to 1½ inches high)
Miscellaneous hardware



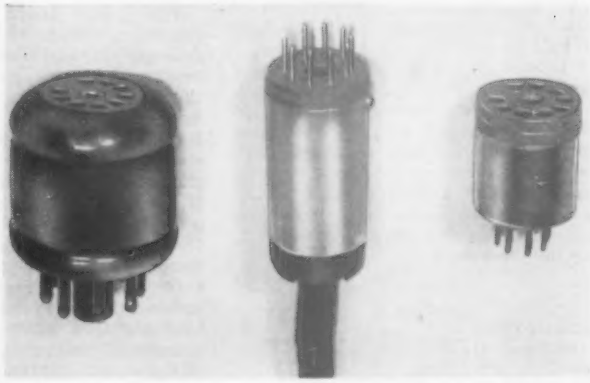
Underchassis wiring is simple

times such removal becomes unnecessary.

Every technician has found, however, that on today's crowded chassis there sometimes is no room for the adapter. It usually is somewhat larger than the tube it replaces. They've also experienced difficulty reaching the contacts on the adapter, and inability to measure current is a decided disadvantage.

Here is an in-cabinet circuit tester which has all the advantages of the familiar test-socket adapters and none of their disadvantages. Basically, it's nothing more than an extension harness, with modifications. The cable plug will replace the tube no matter how crowded the chassis. The tube is then placed in the correct socket on the tester and, with plenty of elbow room, voltage, resistance and some waveform tests can be taken from the tip jacks. [One caution is necessary. In certain circuit positions, cable capacitance may cause circuit oscillation. The tube may then draw more (in some cases, less) current, giving false current readings and upsetting all voltages. The technician will soon learn where he can and where he cannot use this technique.—*Editor*] The jacks are numbered to correspond with the tube pin numbers. Either row of tip jacks may be used for these tests. To check current, the meter is connected to two jacks of the same number and that circuit is broken with the pushbutton between them.

The circuit is very simple. The aluminum case is shortened to make it more convenient to carry. Rubber feet are attached to the bottom to protect furniture when the tester is used in the home. The three tube sockets on the box are wired to the top row of the tip jacks and these to one side of the normally closed pushbutton switches. The other pushbutton connections are wired to the bottom row of tip jacks and to the nine-conductor cable (see schematic and photos). The free end of the cable is terminated with a conventional nine-pin miniature cable plug.



Closeup of the adapter plugs.

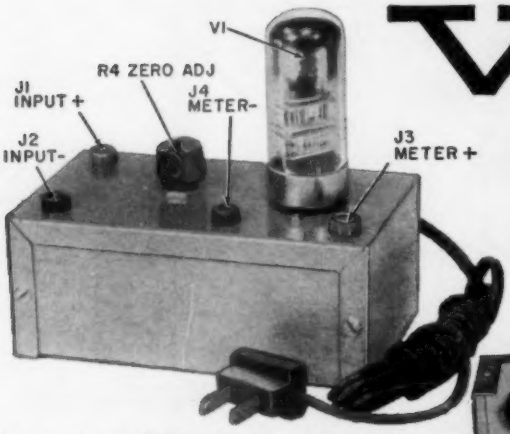
Two adapters are made to use with the cable plug so tests can also be made with seven-pin miniature and octal tube sockets (see photo). The octal adapter is a regular Amphenol octal cable plug modified by removing the cable grommet, enlarging the hole in the housing and soldering a nine-pin miniature socket in place. The seven-pin adapter is built around a Vector seven-pin plug to which a nine-pin socket is soldered. The metal rim of the socket is removed and the composition socket is filed down to accept a short length of ¾-inch diameter thin-wall tubing which covers the connections.

Similar components may be used. The ones suggested, however, go together neatly and compactly.

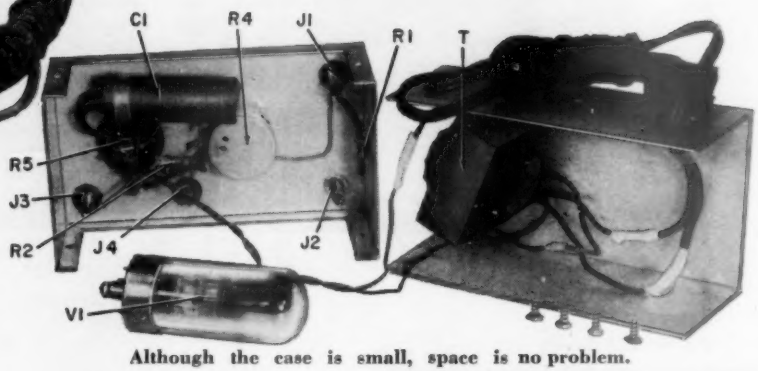
The first day you use the tester in the shop it will repay the time and money invested in building it. END

A simple 1-tube unit turns any vom into a vtvm

LOW-COST VTVM or CONVERTER



The entire unit fits into a miniature aluminum case.



Although the case is small, space is no problem.

By DAVID JOHN LEWIS

IF you are in the market for an inexpensive vtvm, this instrument may deserve your consideration. It can be used with almost any dc voltmeter as a high-impedance vtvm. It will handle both ac and dc.

The basic circuit is a cathode-follower amplifier (see Fig. 1). Since the gain of the cathode follower over a wide range is essentially unity, a voltmeter connected as the load resistance will read the voltage at the input or grid terminals. The amplifier itself has a high input impedance and, therefore, little effect on any circuit to which it may be connected.

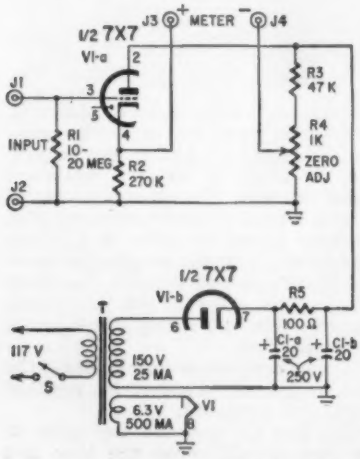


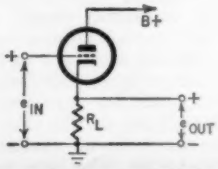
Fig. 1—Circuit of the inexpensive unit.

R1—10-20 megohms
R2—270,000 ohms
R3—47,000 ohms
R4—pot, 1,000 ohms
R5—100 ohms
All resistors ½-watt 10%
C1—20-20 μf, 250 volts, electrolytic
J1, 3—tip jacks, red
J2, 4—tip jacks, black
S—spst
T—power transformer: primary, 117 volts; secondary 150 volts, 25 ma; 6.3 volts, 500 ma (Merit P-3046 or equivalent)
V1—7X7
Chassis box, 2 x 3 x 5 inches
Socket, loctal
Miscellaneous hardware

Fig. 2 is a graph of the output vs the input voltage of a typical cathode-follower circuit. Notice that with zero input a small voltage e_1 appears across the load. R2, R3 and R4 (Fig. 1) balance out this initial reading. In effect it is equivalent to shifting the entire curve downward until it passes through the origin (dotted line). For example, if the input voltage is equal to E, the output or meter reading will be less than this by an amount equal to the voltage balanced out.

It is obvious from Fig. 2 that the meter will always read slightly less than the true input. A small error in the meter reading is also due to part of the output appearing across R4. The loss here is negligible however. Altogether the total error introduced by the amplifier should be less than about 3% of the total input.

The useful range of the amplifier is bounded by the value E. When the input voltage exceeds this upper limit, the grid becomes positive with respect to the cathode and grid current flows. Consequently the input impedance drops to about the voltmeter's resistance. The



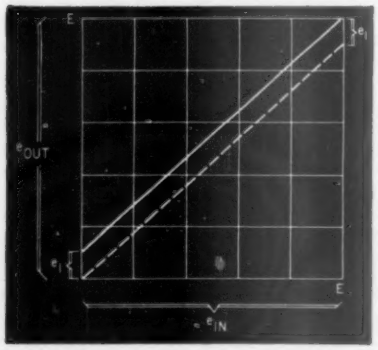


Fig.2—Transfer characteristics of the cathode follower. Dotted line indicates how curve is shifted when e_1 is balanced out.

model described can handle up to 125 volts before this point is reached. This range can be extended, of course, by using appropriate multipliers in the grid circuit.

Measuring ac

The amplifier passes only the positive half-cycles of ac voltages. Nearly all of the negative swing is clipped off. The dc meter in the output reads the average value of the resulting rectified wave. This turns out to be 0.45 times the rms value of the input. In other words the rms value of the input ac voltage can be found by multiplying the meter reading by 2.22.

Alternatively a capacitor can be connected across the meter to maintain the output at a constant level. The meter will read peak value of the input voltage without scale correction factors.

The capacitor can be eliminated if a multimeter equipped with a half-wave rectifier is used in the output. It will be necessary only to switch the meter to an ac range to read the ac input.

Apparently all the voltmeter in the cathode circuit has to do is cover the desired voltage range. Actually, if the resistance of the meter is too low, the instrument will have an amplification considerably less than one. This may preclude the use of very-low-voltage meters.

For example, the model shown is used with a 1,000-ohms-per-volt vom providing dc voltage ranges of 10, 50 and 250 volts. With the meter set to the 250-volt range, the output is about 97% of the input. On the 50-volt range it is only slightly less. However, on the 10-volt range, the meter voltage is only 66% of the input. Of course, since the exact amplification can easily be found with another meter, it is possible to correct any readings made on the lower ranges.

A 2 x 3 x 5-inch Minibox forms the instrument's chassis. The tube socket and all amplifier components are mounted on the upper half of the box, while the transformer is fastened to the base. Pin jacks are used for the meter terminals to take the probe tips of the vom used with the device.

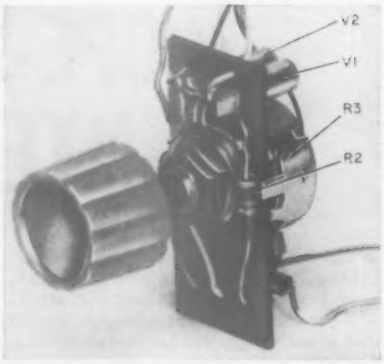
With the exception of the plate voltage, which should be no less than 150 volts—*lower plate voltages will limit the range*—there is nothing particularly critical about the circuit. Any high-mu triode should work well in it. The 7X7 was chosen because its use eliminates the need for a separate rectifier for the power supply. (A 12AX7 with the grid and plate of one triode section connected together to act as a diode would probably work well.—*Editor*)

To use the instrument, plug the meter leads into pin jacks 3 and 4, and adjust R4 for zero meter deflection. If a multimeter is used, set its range switch to give the desired voltage coverage. END

Meter Sensitivity Multiplier

2-transistor circuit changes a microammeter into a sensitive high-input-resistance voltmeter

By I. QUEEN
EDITORIAL ASSOCIATE



The assembled ohms-per-volt multiplier on its small plastic chassis.

AN indication of a voltmeter's quality is its ohms-per-volt input rating—the series resistance needed for a current meter to indicate 1 volt. For example, a 100-μa meter is equivalent to 10,000 ohms per volt (see Fig. 1). Using $E = IR$, it is clear that 1 volt will be indicated when 100 μa flows through 10,000 ohms. The meter's resistance is relatively small and may be ignored.

A conventional vtvm has nearly 4 megohms per volt on its 3-volt range. This high value accounts for its accuracy even when measuring a high-resistance voltage source. A 10,000-ohms-per-volt meter would practically short-circuit such a source.

Fig. 2 shows an adapter that multiplies ohms-per-volt by as much as 40 or more. A pair of complementary

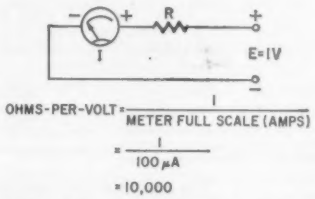


Fig. 1—To get a full-scale reading on a 100-μa meter with 1 volt at E, resistor R must be 10,000 ohms.

transistors is used. Actually only one transistor amplifies. The other one *balances* out the zero-signal current of the amplifier and *compensates* for temperature variations. To prove this, place your finger for a few seconds on one of the transistors and watch the meter deflect because of the higher temperature. Then touch the other transistor and note that the meter deflects in the *opposite* direction. As the 2N217 and 2N647 are nearly equivalent, they make a well-balanced circuit. (Made by RCA they are designed for use in complementary-symmetry circuits such as this one.)

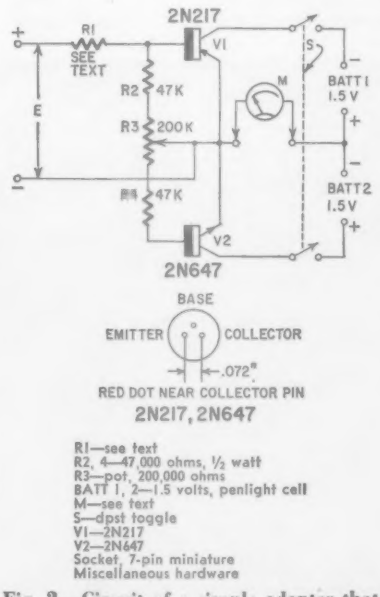
The transistors are plugged into the same seven-pin socket (side by side). This keeps them close together so temperature changes have the same effect on both transistors.

To use the adapter, zero the no-signal current and connect the unit to a dc microammeter. I have tried 20- to 200-μa meters successfully. With a 100-μa meter, R1 must be approximately 400,000 ohms to reach full-scale deflection with 1 volt. With a 50-μa meter, R1 should be approximately 800,000 ohms, etc. R1 should be chosen to provide some convenient full-scale meter value, such as 1 volt. Because of variations among transistors of the same type, a little experimenting is usually needed. Use the transistor that has the higher beta gain for V1, the amplifier.

In my unit, V1 is the 2N217 and V2 is the 2N647. The 2N217 I used has a beta of about 70. My 2N647 measures only about 45.

Each battery is a 1.5-volt penlight cell. A double-pole switch is needed because of the double battery.

The adapter can be built on a plastic board only 1 x 2 inches and added to any meter or chassis. Of course this does not include batteries, switch or meter. END



R1—see text
R2, 4—47,000 ohms, ½ watt
R3—pot, 200,000 ohms
BATT 1, 2—1.5 volts, penlight cell
M—see text
S—dpst toggle
V1—2N217
V2—2N647
Socket, 7-pin miniature
Miscellaneous hardware

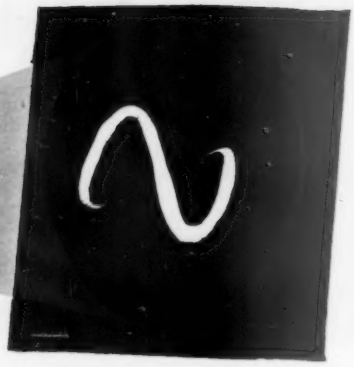
Fig. 2—Circuit of a simple adapter that multiplies ohms-per-volt ratings 40 times or more.

TEST INSTRUMENTS

For less than $2 you can make your scope screen easy to photograph

SIMPLEST SCOPE-BEAM INTENSIFIER

By TOM JASKI



GOOD cathode-ray tube photography calls for a bright trace, even with the fastest film available. Standard kit type scopes are usually designed primarily for viewing, and sometimes the trace is not quite bright enough for taking a good picture. But there is a very simple remedy, which is described here.

Fig. 1 is a partial schematic of a Heath O-10 oscilloscope. In it you will see two minor modifications. Each brightens the trace and requires very few parts. Alternate 1 consists of breaking the high-voltage connection to the plate of the high-voltage rectifier tube (1V2) and bringing the two sides of the broken circuit out to phone-tip or banana jacks on the rear of the scope. These jacks are normally connected through a shorting plug.

For trace brightening, you take out the shorting plug and connect an ac voltage from a transformer into the circuit. The capacitors in the high-voltage filter of the Heath scopes are rated for 1,600 volts, but the supply provides only about 1,250. So without danger to the capacitors, you can add about 250 volts rms to the high-voltage supply. This we connect to the jacks. The rectifier will still rectify it and the capacitors still filter it, but the voltage is now 1,600 and the trace much brighter.

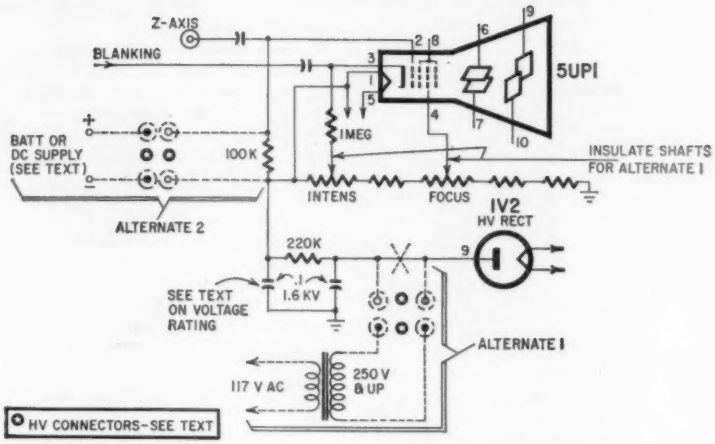
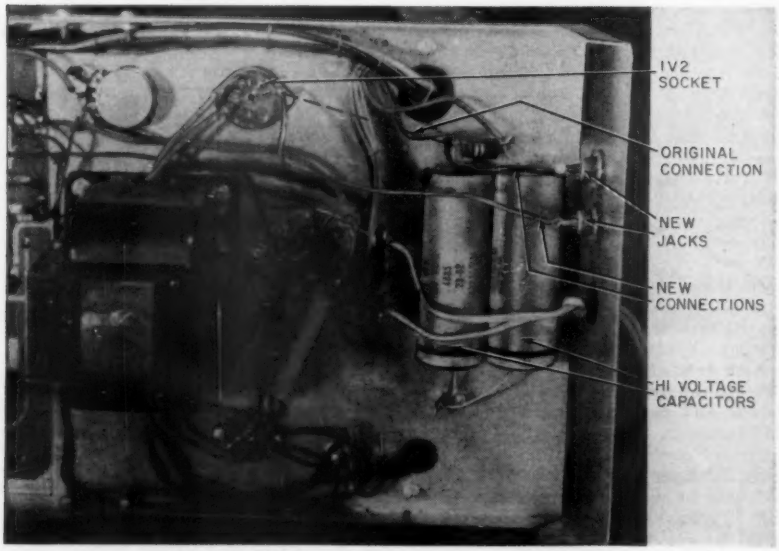


Fig. 1—Partial schematic shows simple circuit modifications for intensifying the scope trace.



Only two jacks and two wires are needed to provide for beam intensification with an ac voltage.

The added voltage must be phased for series-adding to the high-voltage winding on the transformer, but this is no problem—if the trace gets weaker instead of brighter, reverse the power plug of either the scope or the transformer.

If you want still higher voltages (the 5UP1 cathode-ray tube can take 2,200 volts), you will have to increase the value of the capacitors. This can be done by putting two 0.25-μf 600-volt units in series with the present capacitors. These will then add to the voltage just about their working voltage rating, but the total capacitance will be a little less. Yet sufficient filtering will take place. The total capacitance of each filter will be about .07 μf.

There is one big advantage to this method and one big disadvantage. The advantage is that the focusing does not change, since the focusing voltage also increases. This means that you can use a momentary brightening of the trace for photography, triggered through the camera sync contacts and a relay (see Fig. 2). The disadvantage is that the scope's sensitivity is reduced a little. Thus, with 250 volts rms on the connections, you will lose about 10% sensi-

For normal operation, the jacks are connected with a shorting plug. Remember to turn off the scope before you remove it. It's hot—approximately 1,250 volts!

tivity, and with 2,200 volts maximum (600 volts rms added) you will lose about 20% deflection. But this may not be serious.

One note of caution: If you are going to add a lot of voltage, insulate the focus and intensity controls from the case, or flashover will almost certainly occur. This is really simple, enlarge the holes from ⅜ inch to ½ inch and use a set of standard shoulder washers, either fiber or bakelite. Or use a ½-inch rubber grommet with a ⅜-inch hole.

Another method

The other brightening method shown in Fig. 1 consists of connecting the two added jacks to the ends of the 100,000-ohm grid dropping resistor. Then you will not need a shorting plug. Putting a dc voltage across this resistor will really brighten the trace, but it will throw off the focusing, and the focusing control must be readjusted. Fortunately there is a lot of leeway in this control. The voltage added across the resistor can be anything from 30 to 150, depending on how bright you want the trace and how far your focusing control will readjust.

Another disadvantage of this method is that, with the brightened trace, a much greater voltage is needed for Z-axis modulation. With method 1, there is some increase in Z-axis voltage, but at least the impedance of the grid circuit is the same. In the second method, the impedance of the dc source parallels the grid resistor, and thus more voltage is required for the same modulation.

The transformer used in the first method can be almost any unit, so long as you remember that its high-voltage winding is now at the scope's dc voltage. Most transformers will take this. Current requirements are practically nil, and the relay (if used) can be run off the filament winding if you use a small power transformer.

Don't try to build the transformer into the scope. You will run into trouble with magnetic pickup unless you do a lot of shielding.

This is a simple, inexpensive—less than $2—solution to trace brightening. Why not give it a try? END

(Make sure that the scope is turned off and that the brightener transformer is unplugged from the ac line before setting up the brightener for use. The jacks may have 1,500 volts or so on them, and there is 250 volts or more across the plugs when the transformer is plugged into the power line. Ordinary phone-tip and banana plugs can be dangerous. Play safe. Use safety type high-voltage connectors such as the James Millen type 37001. A second set of the male connectors tied together acts as a safe shorting plug.—*Editor*)

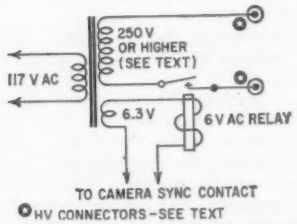
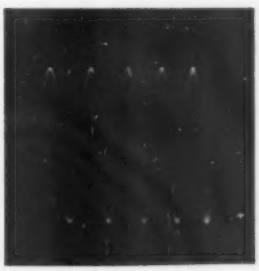
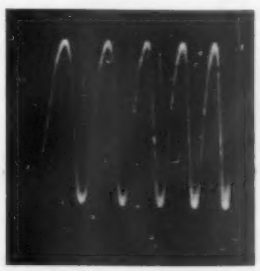


Fig. 2—Use a relay triggered by the camera to intensify the beam only when the camera shutter is open.



a



b

Intensifying the beam makes a difference: a—without intensification; b—same trace with intensification. (Lens opening, shutter speed and film speed identical for both photos.)

TEST INSTRUMENTS

How to Burn Out A Voltmeter

Don't laugh, it could happen to you!

By WARREN J. SMITH

WHO ever heard of burning out a voltmeter by measuring the ac heater voltage of a 6.3-volt tube on the meter's 12-volt range? I have—I did!

The receiver was a Sylvania, chassis 1-502-1, in which a do-it-yourself fan had attempted a homey type repair, meaning a butchered-up underside. However, a cursory visual check showed everything to be, in a sloppy sort of way, in apparent order. So I fired the little monster up and stood back, away back, to await the results. All but four of the tubes lit up with a friendly glow and none of the expected smoke poured forth. Suspecting that a lead from the heater string was lying on the set owner's workbench at home, I clipped the ground lead of my dependable ol' voltmeter to the chassis and probed at what I thought was the hot side of the 6T8 ratio detector heater. *Wham!* It was hot all right, and the expected smoke issued forth from an unexpected source—my voltmeter. A small puff, to be sure, but the indication was definite. I had burned out a good instrument because I didn't take the time to dig out the set's schematic. If I had, I might have noticed that about half of the heater string was −135 volts with respect to the chassis!

We all know better than to measure the heater voltage of a damper or low-voltage rectifier. But what you don't know about heater-circuit arrangements can hurt you financially. In many of the sets manufactured during the last few years, the cathodes of one or more tubes (other than the damper and low-voltage rectifier) are 100 volts—or more—positive with respect to the chassis. And, often, the heaters of these tubes are biased to cathode potential to prevent electrical stress between these elements. Examples of this unorthodox circuit arrangement can be found in sets manufactured by Bendix, Crosley, Hoffman, Magnevox, Motorola, Raytheon, RCA, Sylvania and possibly others. The stages in which this phenomenon occurs is sometimes surprising too—sound if amplifiers and age keyers to name but two!

The safest approach to heater voltage measurements is, **don't measure it,** or if it is necessary for some reason or another, measure it **across** the tube's heater pins. Series or series-parallel heater strings in transformerless sets present another problem—that of the line voltage across an open heater. But with a little care no unusual problem, like a burned-out voltmeter, should occur. END

Compact system uses oval cone driver. Acoustical padding is visible inside cabinet. Material added to cone moves at low frequencies, is inert at highs. Assembled unit on right.

Variable damping gives this small stereo speaker system a wide frequency response

SPEAKER DAMPING is in the CONE

By CHARLES B. GRAHAM

IN the past, when speaker design engineers aimed for low resonance or smooth response, they often had to sacrifice efficiency. And when they developed a very efficient unit, they found it difficult to keep its frequency response as smooth or its low-frequency resonance as low as desirable.

In this stereo speaker system, the designer uses conventional cone drivers that are modified and loaded so their effective cone mass varies inversely with frequency. As the frequency drops, the effective mass of the cone—the mass the voice coil must move—increases.

Weathers Industries, designer and manufacturer of these speaker systems, has developed two units that use the variable-mass principle. One is a full-range speaker shaped like a medium-sized dictionary, intended for pairing to make up what Weathers calls its Harmony Duo. The other unit, whose addition to the Duo system completes the Harmony Trio, is a bass-extender system (Hideaway) the size of a small suitcase. It reproduces the combined bass signals of both channels below 100 cycles.

The variable-mass principle is used in slightly different ways in the Harmony and the Hideaway bass units, as will be shown.

Full-range unit

Photo (left) shows full-range speaker system with front grille removed and the driver out of its enclosure. A finished unit is at the right. When assembled, the speaker's metal basket is slipped into the book-sized enclosure and sealed so that it is airtight. The only visible additions to the driver are two pieces of specially impregnated material attached to the cone.

The cone is made of a particularly light material, whose low mass gives the speaker high efficiency. Its long, oval shape was dictated partly by the requirements for wide-angle high-frequency dispersion and partly to let the designer use the book-on-the-bookshelf or mount-it-anywhere approach. The two pieces of material attached to the cone add some additional mass to most of the cone area (see Fig. 1). Here's how they work.

At frequencies above about 250 cycles, the extra mass over most of the cone restricts its vibration, so that sound is radiated only from the small area directly around the voice coil. Below 250 cycles, some of the added mass is able to respond, so a larger area radiates sound. The flexibility of the specially impregnated material lets that area vibrate without driving the rest of the cone with it. A deadening characteristic of the impregnation keeps the flexing material from producing an audible rustling.

At 100 cycles, the entire mass of the cone plus its added mass element come into action, so the whole area of the speaker cone is responding.

This effect offsets the normal tendency for the speaker's output to increase with rising frequency—a result of its small physical size. In addition, restricting cone action to specific radiating areas reduces cone breakup, which occurs to some degree in all speaker diaphragms. The acoustical padding inside the enclosure adds some extra acoustical resistance to the entire speaker.

The bass speaker

The Hideaway bass speaker also uses the variable-mass principle, but is loaded additionally from the slot source horn through which the speaker's output passes. A highly efficient cone driver with a weighted cone is used, and a large piece of specially treated material almost fills the front of its cone (photo next page). The path of sound waves coming from the bass cone is shown in the cross-sectional view (Fig. 2). Here, as with the full-range unit, the speaker basket has an airtight seal to the enclosure, but there is no acoustical padding inside because the speaker is already heavily damped and the enclosure is too small to support resonances at the low frequencies within the woofer's operating range.

The volume of the cavity behind the cone is carefully calculated, of course, and is closely related to the mass of the cone, its mechanical and acoustical damping, and the configuration of the front-loading slot.

In the bass speaker (photo and Fig. 2), the impregnated material attached to the cone loads it so that it moves very little at 100 cycles and begins to move with the cone from 70 to 35 cycles. Below 35 cycles, the plug becomes, in effect, part of the cone, carrying the speaker's response downward until loss of air coupling drops the acoustic output.

When combined to form a speaker system, the book speaker carries the range down to 80 cycles, at which point the speaker is slightly below its maximum output. The bass speaker is rather flat from 35 to 70 cycles, and begins to fall off at 80 cycles, providing a smooth crossover transition with the full-range speaker. At the low end, the bass speaker falls off gradually below 30 cycles. The frequency response of the combined full-range and bass speakers goes from 35 to 15,000 cycles.

Without the added mass of the fiber material, the bass speaker's cone would resonate near 70 cycles. The additional material pushes the system's natural resonance down to 45 cycles, and the additional air loading drops it to 35.

The efficiency of the bass speaker depends to some extent on its placement in the room. On the floor next to a wall, its efficiency is around 7%.

Bass-extending woofer with top removed to show special damping material that almost fills cone. Mixing network and volume control for its power amplifier at lower right.

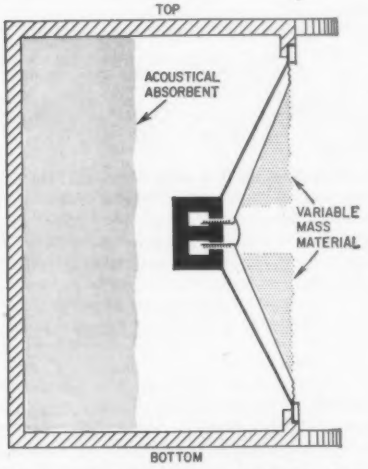


Fig. 1—Book-shape enclosure has acoustical padding behind cone to damp resonances in small cabinet.

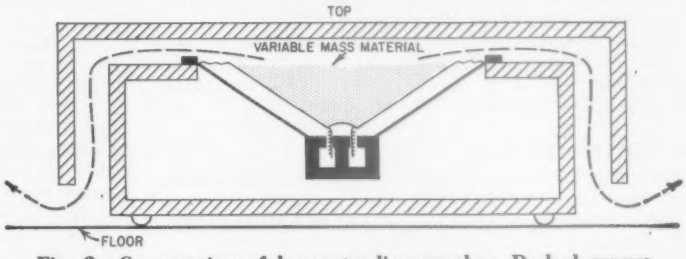


Fig. 2—Cross-section of bass-extending speaker. Dashed arrows show path of sound through modified slot source horn.

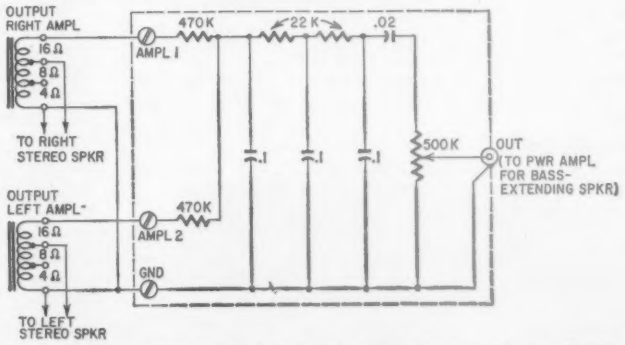


Fig. 3—Bass mixing network has isolating resistors at inputs from power amplifiers, multi-section treble-loss filter and level control.

This just matches the efficiency of the full-range unit. Placed in a corner, it will be better coupled to the air mass of the room and its efficiency will be nearer 10%. These high orders of efficiency are due in part to the use of light cones and aluminum voice-coil windings.

The absence of sound directionality at frequencies below about 300 cycles is used in this system so the single bass unit can handle the lows from two stereo channels, without losing stereo directionality. Bass combining takes place in a small passive crossover network box supplied with the bass-extending speaker. The network (Fig. 3) is connected to the 16-ohm output taps on the main stereo amplifiers. It takes the bass components of both channels, mixes and feeds them through a level control to a third power amplifier connected to the bass speaker.

Although the particular speakers discussed here are made primarily for use as stereophonic reproducers, the principle of variable-mass loudspeaker loading is readily applicable to monophonic speaker systems. It will be noted that, because of their small size and wide-angle high-frequency dispersion, these Harmony speakers lend themselves to stereo placement. END

ANOTHER FIRST FOR HEATHKIT®
. . . amplifier power rating standards

Heathkit is accustomed to pioneering . . . to leading the way. We led the way into the kit field of electronic equipment. Now, we are leading the way to audio amplifier power rating standards . . . standards clearly defined to assure you of Heathkit quality . . . to enable you to compare before you buy.

The Heathkit amplifier standards have been established upon these following beliefs after reviewing over one hundred published treatises on the subject:

WE BELIEVE any amplifier should be rated for its intended use . . .

PROFESSIONAL amplifiers must be so nearly perfect that no audible change occurs in the program material.

HIGH FIDELITY amplifiers must be almost as perfect, almost as efficient.

UTILITY amplifiers can be less perfect and still fulfill their practical job.

WE BELIEVE the rated power of an amplifier in any of the above "use" categories should be that power which satisfies all requirements in that category.

Each of the three "use" categories we have chosen has requirements which can be translated into performance specifications with rather definite limits . . . limits established by recognized authorities. The Heath requirements and their limits for each of the categories are as follows:

PROFESSIONAL RATING

The professional power rating shall be that power which satisfies the following five tests:

1. Maximum power at which total harmonic distortion (THD) does not exceed 0.3% at 1000 CPS.
2. Maximum power at which total harmonic distortion (THD) does not exceed 2.0% at 20 CPS.
3. Maximum power at which total harmonic distortion (THD) does not exceed 2.0% at 20,000 CPS.
4. Maximum power at which response does not deviate by more than ±1 db between 20 and 20,000 CPS.
5. Maximum equivalent single-frequency power at which intermodulation distortion does not exceed 1.0% (60 and 6000 CPS, 4:1).

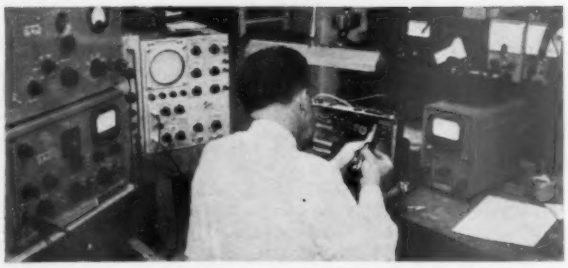
HIGH FIDELITY RATING

The high fidelity power rating shall be that power which satisfies the following five tests:

1. Maximum power at which total harmonic distortion (THD) does not exceed 0.7% at 1000 CPS.
2. Maximum power at which total harmonic distortion (THD) does not exceed 2.0% at 30 CPS.
3. Maximum power at which total harmonic distortion (THD) does not exceed 2.0% at 15,000 CPS.
4. Maximum power at which response does not deviate by more than ±1 db between 30 and 15,000 CPS.
5. Maximum equivalent single-frequency power at which intermodulation distortion does not exceed 2.0% (60 and 6000 CPS, 4:1).

UTILITY RATING

The utility power rating shall be that power which satisfies the following five tests:



1. Maximum power at which total harmonic distortion (THD) does not exceed 1.0% at 1000 CPS.
2. Maximum power at which total harmonic distortion (THD) does not exceed 3.0% at 60 CPS.
3. Maximum power at which total harmonic distortion (THD) does not exceed 3.0% at 7000 CPS.
4. Maximum power at which response does not deviate by more than ±1 db between 60 and 7000 CPS.
5. Maximum equivalent single-frequency power at which intermodulation distortion does not exceed 3.0% (60 and 6000 CPS, 4:1).

We at the Heath Company are now rating all our amplifiers to these standards. To show you just how this rating system works, let's look at the Heathkit EA-3 amplifier:

As a professional amplifier—

1. Maximum Power at which T.H.D. does not exceed 0.3% at 1000 CPS: 15.1 watts
2. Maximum Power at which T.H.D. does not exceed 2.0% at 20 CPS: 13.9 watts
3. Maximum Power at which T.H.D. does not exceed 2.0% at 20,000 CPS: 15.3 watts
4. Maximum power at which response does not deviate more than ±1 db between 20 and 20,000 CPS: 17.6 watts.
5. Maximum equivalent single-frequency power at which intermodulation distortion (60 and 6000 CPS, 4:1) does not exceed 1%: 18.0 watts.

Taking that power which satisfies all five tests, we could rate the EA-3 for professional use, at 13.9 watts. Its advertised professional rating is a conservative 12 watts.

A review of the chart below shows why the EA-3 is rated at 14 watts for high fidelity applications, and 16 watts as a utility amplifier.

Notice that our specifications are set at rated power for one or more classifications (when our customers need an amplifier for a particular use, we believe thay want it to deliver its rated power under those particular conditions). Observe that our distortion figures are specified at the limits of the amplifier frequency range as well as at the traditional 1000 CPS (the common practice of rating distortion only at 1000 CPS does not tell you what happens throughout the full range of the amplifier).

As an example of how these standards work on several competitive amplifiers, we have prepared the following chart. Notice that if the amplifiers did not meet standards at rated output power, we have determined the power output where they do meet the standards set up under the three categories.

AMPLIFIER COMPARISON CHART

Amplifier Description and Price	Heath Standard Rating		Maximum Power Output Satisfying:				
	Classification	Power (watts)	Power Rating at Test 1 Stds.	Power Rating at Test 2 Stds.	Power Rating at Test 3 Stds.	Power Rating at Test 4 Stds.	Power Rating at Test 5 Stds.
Kit "A" "12 w. HI FI" $23.90	Professional	Disqualified	8.4 watts	0.02 watts	0.65 watts	Disqualified	3.9 watts
	High Fidelity	Disqualified	9.1	1.3	1.67	Disqualified	5.9
	Utility	8.6 watts	9.8	8.9	8.6	12.3 watts	11.6
Assembled Amp. "B" "14 w. HI FI" $39.50	Professional	0.3	4.7	0.3	4.8	1.2	4.0
	High Fidelity	1.1	12.1	1.1	5.7	5.3	8.2
	Utility	7.8	13.2	7.8	12.9	15.8	13.9
Kit "C" "12 w. HI FI" $34.95	Professional	3.6	11.0	3.6	7.5	7.5	6.5
	High Fidelity	8.0	11.8	8.0	11.2	13.4	14.3
	Utility	11.9	12.0	12.0	11.9	15.0	14.9
Assembled Amp. "D" "15 w. HI FI" $64.50	Professional	3.8	13.2	3.8	14.5	12.0	14.6
	High Fidelity	10.6	14.3	10.6	14.5	18.3	16.3
	Utility	14.7	14.7	14.7	15.0	23.7	17.0
Heathkit EA-3 "14 w. HI FI" $29.95	Professional	13.9	15.1	13.9	15.3	17.6	18.0
	High Fidelity	15.5	16.2	15.8	15.5	18.3	18.9
	Utility	16.4	16.5	16.6	16.4	19.0	19.5

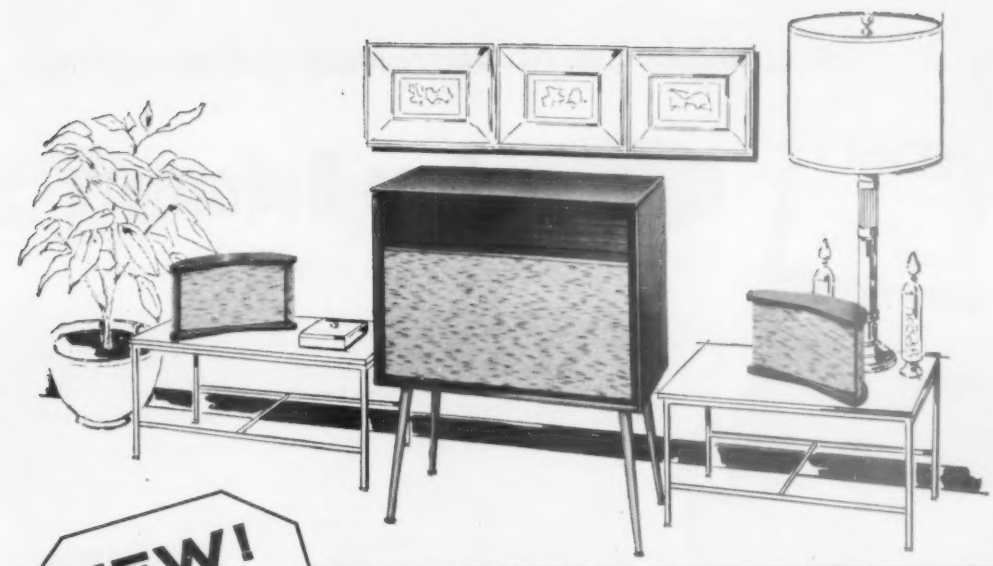
The Heathkit amplifier power rating standards have been established as further assurance to you of the high quality of our products. We will live by these standards until industry-wide standards are established.

HEATHKIT®

HEATH COMPANY

Benton Harbor 20, Michigan

a subsidiary of Daystrom, Inc.



NEW! from the HEATHKIT AUDIO LABS

BRAND NEW! a complete Heathkit Stereo "Package"

THRILL TO A NEW DIMENSION IN STEREO SOUND

HEATHKIT SD-1 B (birch or SD-1 M (mahogany)

$179.95

(cabinet legs included; end tables not included)

HI-FI STEREO SYSTEM KIT

For the first time anywhere . . . a stereo-kit package, ready-to-play after only a few hours assembly time and complete with cabinet, stereo amplifier, stereo record changer, bass woofer and stereo speaker wings. And the unbelievably low price sets an unprecedented record for stereophonic systems of this quality anywhere on the market. One of the factors behind this phenomenal achievement is the introduction of the revolutionary stereophonic "sum and difference" amplifier used in this kit—licensed in kit form exclusively by Heath Company from CBS Laboratories. This unique development in audio science employs a new principle of stereophonic reproduction. The single chassis amplifier separates the individual stereo channels by utilizing the sum and difference of the total signal and directing the sound to the appropriate right and left channels, reproduced by the stereo wing speakers. The centrally located woofer reproduces the non-directional bass frequencies. The result of this modern stereo reproduction is a breath-taking experience of sound coming to you with depth and direction seldom achieved by conventional stereophonic methods. The beautifully styled console cabinet houses the stereo amplifier, stereo record changer and low-frequency woofer. Controls on the handsome black and gold amplifier panel consist of: on-off switch, bass and treble tone controls, input selector switch and level balancing control. The new CBS sum-and-difference or matrix-type circuit employs only four tubes and is extremely easy to assemble. The woofer, mounted behind the attractive grille cloth, is a high compliance 8" speaker capable of 30 cycle response when housed in the acoustically designed ducted-port enclosure. The specially designed crossover employs a dual bass-mixing 250 cycle network. The twin stereo speakers are 6" x 9" extended range dual cone oval speakers. The completely automatic, four speed record changer employs a ceramic stereo cartridge with micro-groove diamond stylus capable of obtaining the best from the latest stereo or LP monophonic recordings. A 45 RPM spindle is also included for 45 RPM monophonic or stereo records. Separate inputs are provided for AM/FM tuners or multiplex. Both in styling and performance, the all-new SD-1 Stereo offers you the greatest Heathkit value in years. Shpg. Wt. 88 lbs.

- 9 Watt High Fidelity Rating (monophonic)
- Complete—No "Extras" to Buy
- Revolutionary Stereo Amplifier
- Assemble in Just a Few Hours From Easy Step-By-Step Instructions
- Beautifully Styled Cabinetry
- Stereo Sound With Such Impact You'll Find It Hard to Believe!

SPECIFICATIONS—Overall System Frequency Response: ±5 db, 30-16,000 cps. Amplifier: (push-pull conditions except where specified). Power versus Distortion: 10 watts, less than 3 ¾ THD from 30-16,000 cps. 9 watts, less than 2½ THD from 30-16,000 cps. 1 watt, less than 0.7½ from 30-16,000 cps. Peak Power: 20 watts: Mid-range individual channel power, 5 watts. Frequency Response: Tuner input, tone controls in mid-position. 1 watt level, ±1 db, 30-16,000 cps. Ceramic cartridge input—equalized for RIAA characteristics. Input Sensitivity: 0.1 volt at 1000 cps to each tuner input for 10 watt output. Hum and Noise: 70 db below 10 watt level with inputs shorted. Channel Separation at Significant Frequencies: (2 watt level on operating side). 250 cps—29.0 db. 1 kc—34.0 db .2 kc—35.0 db. 2 kc—35.0 db. 5 kc—36.0 db. 8 kc—37.0 db. 12 kc—35.0 db. 16 kc—29.0 db. Overall Channel Separation: using RCA test record #1427-1, cartridge supplied, 1000 cps, 20 db. Bass Tone Control 50 cps: accentuation 8 db. Attenuation 9 db. Treble Tone Control 10 kc: accentuation 9 db. Attenuation 7 db. Power Requirements: 117 volts, AC, 60 cycles, 75 watts. Crossover Network: crossover freq.—250 cps. Attenuation rate 12 db per octave. Power rating—5 watts per channel. Changer: speeds—16, 33⅓, 45, 78 rpm. Cartridge: ceramic stereo, out-of-phase connected (.0008" diamond stylus). Cabinets: dimensions—main cabinet, 30" wide x 34½" high x 15" deep. Satellite speaker, 14¼" wide x 8" high x 6½" deep.

EASY TIME PAYMENTS

The thrills of stereo sound from this New Heathkit Stereo System can be yours NOW . . . while you pay in easy installments.

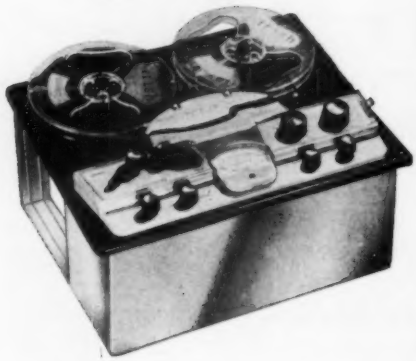
a complete line of stereophonic and monophonic

NEW! from the HEATHKIT AUDIO LABS

HEATHKIT

Tape Recorders

Field Tested for One Year



SPECIFICATIONS—Tape Speed: 7.5 and 3.75" per second. Maximum reel size: 7". Frequency response: (record-playback): ±2.5 db, 30-12,000 cps at 7.5 IPS. ±2.5 db, 30-6,500 cps at 3.75 IPS. Harmonic distortion: 1% or less at normal recording level; 3% or less at peak recording level. Signal-to-noise ratio: 50 db or better, referred to normal recording level. Flutter and wow: 0.3% RMS at 7.5 IPS, 0.35% RMS at 3.75 IPS. Heads (3): erase, record, and in-line stereo playback. Playback equalization: NARTB curve, within ±2 db. Inputs (2): microphone and line. Input impedance: 1 megohm. Outputs (2): A and B stereo channels. Output levels: approximately 2 volts maximum. Output impedance: Approximately 600 ohms (cathode followers). Recording level indicator: professional type db meter. Bias-erase frequency: 60 kc. Timing accuracy: ±2%. Power requirements: 105-125 volts AC, 60 cycles, 32 watts. Dimensions: 15½" W. x 13½" D. total height 10¾". Mounting: requires minimum of 8⅛" below and 1⅛" above mounting surface. May be operated in either horizontal or vertical position.

NEW PROFESSIONAL-TYPE TAPE RECORDER KITS

Designed to take their place in the finest of hi-fi systems, the new models TR-1C and TR-1D Tape Recorders will provide superb performance for years to come. These completely field tested, precision engineered instruments provide monophonic record and playback in the TR-1C or monophonic record and playback plus stereo playback in the TR-1D.

The mechanical assembly, with fast forward and rewind, is completely finished and adjusted—you build only the tape amplifier. Easy to assemble, the amplifier features two circuit boards which virtually eliminate wiring errors and assure the high stability necessary for consistently good results.

Low noise EF-86 tubes in input stage and push-pull bias erase oscillator assure maximum freedom from hum and noise in recording and playback.

Two inputs are provided (mike and high level line) for recording from microphone, preamplifier, tuner, phono, or TV. In the TR-1D, a separate playback channel with cathode follower output is provided for each stereo track—one of the stereo channels is used for monophonic playback.

Separate record and playback heads and amplifiers allow monitoring from tape while recording. Built-in sound level meter indicates proper recording level and bias for top quality recordings. A pause control allows instant starting and stopping of tape for accurate cueing and tape editing. Kit includes counter for cueing and editing ease.

The precision tape mechanism features heavy duty fan cooled motor, balanced flywheel, long-life bearings, and positive acting braking system. Push button provides instant selection of 3¾ or 7½ IPS tape speed. Safety interlock on record switch minimizes the possibility of accidental erasing. The handsome styling includes plastic escutcheon in soft gold mounted on semi-gloss black panel with black knobs with gold inserts. Complete instructions provided for assembly and operation. This outstanding kit offers a combination of features found only in higher priced professional tape decks selling for $350 to $400.

MODEL TR-1C Monaural Tape Deck: Has all features of model TR-1D with the exception of stereo playback. Shpg. Wt. 30 lbs. **$159.95**

MODEL TR-1D Stereo Tape Deck: Provides monaural record and playback and stereophonic playback of the pre-recorded tapes (stacked). Shpg. Wt. 30 lbs. **$169.95**

MODEL C-TR-1C Conversion Kit: Converts model TR-1C to include stereo function of model TR-1D. **$19.95**

NOW! FULL STEREO CONVERSION FOR TR-1A OWNERS

MK-4 Half-Track Stereo Conversion Kit: Modifies TR-1A monaural tape recorder to include function of record and playback of half-track stereo program material. Consists of a TE-1 tape preamplifier, a stereo head array plus components and instructions to convert TR-1A to TR-1AH. **$62.95**

MK-5 Quarter-Track Stereo Conversion Kit: Modifies TR-1A monaural tape recorder to include function of record and playback of quarter-track stereo. Allows playing stereo both ways on standard tape for twice the playing time or four times playing time with monophonic recordings. Consists of a TE-1 tape preamplifier, a stereo head array plus components and instructions to convert TR-1A to TR-1AQ. **$62.95**

HEATHKIT

NOW! TWO NEW STEREO-MONO TAPE RECORDERS IN THE TR-1A SERIES

Our most versatile tape recorder kit, the model TR-1A now can be purchased in any one of three versions. You can buy the new half-track (TR-1AH) or quarter-track (TR-1AQ) versions which record and play back stereo and monophonic programming, or you can buy the original monaural version (TR-1A) and add either half-track or quarter-track stereo provisions later using the MK-4 or MK-5 Conversion kits. The tape deck is extremely simple to assemble and uses precision bearings throughout the rugged mechanism assuring long and faithful service. One control lever selects all tape handling functions on the deck, greatly simplifying operation. Speeds of 7.5 or 3.75 IPS are available. Flutter and wow are held to less than 0.35%. Each tape preamplifier features NARTB playback equalization, separate record and playback gain control, cathode follower output and provision for mike or line input. Record level is indicated on "magic eye" tube. A safety interlock is provided to minimize accidental erasure of tape. Filament balance control allows adjustment for minimum hum level. Cathode follower output from playback channel is approximately 600 ohms impedance. Two circuit boards are used for easy assembly. Supplied with attractive vinyl-clad steel cover in black leather texture, with inlaid gold design. Templates and instructions provided for panel mounting or equipment enclosure installation.

NOW AVAILABLE IN THREE MODELS!

MODEL TR-1A: Monaural record/playback with fast forward and rewind functions. Shpg. Wt. 24 lbs. **$99.95**

TR-1A SPECIFICATIONS—Frequency Response: 7.5 IPS ±3 db 50-12,000 cps. 3.75 IPS ±3 db 50-7,000 cps. Signal to Noise Ratio: Better than 45 db below full output of 1.25 volts /channel. Harmonic Distortion: Less than 2% at full output. Bias Erase Frequency: 60 kc (push-pull oscillator).

MODEL TR-1AH: Monaural and half-track stereo record/playback with fast forward and rewind functions. Shpg. Wt. 35 lbs. **$149.95**

TR-1AH SPECIFICATIONS—Frequency Response: 7.5 IPS ±3 db 40-15,000 cps. 3.75 IPS ±3 db 40-10,000 cps. Signal to Noise Ratio: 45 db below full output of 1 volt /channel. Harmonic Distortion: Less than 2% at full output. Bias Erase Frequency: 55 kc (push-pull oscillator).

MODEL TR-1AQ: Monaural and quarter track stereo with record/playback fast forward and rewind functions. Shpg. Wt. 35 lbs. **$149.95**

TR-1AQ SPECIFICATIONS—Frequency Response: 7.5 IPS ±3 db 40-15,000 cps. 3.75 IPS ±3 db 40-10,000 cps. Signal to Noise Ratio: 40 db below full output .75 volts /channel. Harmonic Distortion: Less than 2% at full output. Bias Erase: 55 kc (push-pull oscillator).

monophonic or stereo Hi-Fi

HEATHKIT

Program Sources

NEW

MODEL FM-4

$34.95

SPECIFICATIONS—Tuning Range: 88—108 mc. Quieting Sensitivity: 2.5 uv for 20 db of quieting. 3.5 uv for 30 db of quieting. 25 uv for maximum quieting (45 db). IF Frequency: 10.7 mc. Image Ratio: 45 db. AFC Correction Factor: 75 kc per volt. AM Suppression: 25 db. Frequency Response: ±2 db 20-20,000 cps. Harmonic Distortion: Less than 1.5%, 1100 uv, 400 cycles 100% modulation. Intermodulation Distortion: Less than 1%, 60 cycle and 8 kc mixed 4:1 1100 uv, 30% modulation. Antenna: 300 ohms unbalanced. Output Impedance: 600 ohms (cathode follower). Output Voltage: nominal .5 volt (with 30% modulation, 20 uv signal). Power Requirements: 105-125 volts 50/60 cycle AC at 25 watts. Overall Dimensions: 4¼" H. x 13¼" W. x 5½" D.

NEW HIGH FIDELITY FM TUNER KIT (FM-4)

This superbly designed unit incorporates advancements in circuit design with features asked for by hi-fi fans everywhere. Better than 2.5 microvolt sensitivity, automatic frequency control (AFC) with defeat switch, flywheel tuning and prewired, pre-aligned and pretested tuning unit . . . bring you the finest in FM listening entertainment. The exceptionally clean chassis layout, pre-aligned IF transformers and the prewired, pre-aligned tuning unit insure ease of construction with no further need of alignment after the unit is completed. The five tube circuit features a generous power supply utilizing a silicon diode rectifier for cool running operation and low power consumption. The attractive styling of the FM-4 features a vinyl-clad steel cover with leather-like texture, soft black front panel, set off with brushed-gold trim and new soft evenly-lit dial scale. A multiplex adapter output is provided. Feature for feature the FM-4 offers the most outstanding dollar value in FM entertainment available today. Shpg. Wt. 8 lbs.

MODEL PT-1

$89.95

MONOPHONIC-STEREO AM-FM TUNER KIT (PT-1)

Outstanding features in both styling and circuitry are combined in this 16-tube deluxe stereo AM-FM combination tuner to bring you the very finest of program sources for your listening enjoyment. Features include three printed circuit boards for easy construction and high stability—wired, pre-aligned 3-tube FM tuning unit—built-in AM rod antenna—tuning meter—automatic frequency control (AFC) with on-off switch—and flywheel tuning. Other features include variable AM bandwidth, 10 kc whistle filter, tuned-cascode FM front end, FM AGC and amplified AVC for AM. AM and FM circuits are separate and individually tuned so they can be used simultaneously for stereo applications. Cathode follower outputs with individual level controls are provided for both AM and FM, with a multiplex adapter output provided. A tuning meter and flywheel tuning combined with two edge-lit slide rule scales provide effortless tuning. Styling features vinyl-clad steel cover in black with inlaid gold design and soft black, rigid die-cast panel set off by brushed gold trim, black knobs with gold inserts. Shpg. Wt. 24 lbs.

MODEL BC-1A

$26.95

HIGH FIDELITY AM TUNER KIT (BC-1A)

Delivers AM broadcast reception comparable to FM quality. Features a special detector using crystal diodes and broad-band IF circuits for low signal distortion. Prealigned RF and IF coils eliminate the need for special alignment equipment. Sensitivity better than 3 microvolts for one volt output. Two output levels provided. Built-in power supply. Special antenna supplied, also provision for outside antenna. Shpg. Wt. 9 lbs.

MODEL FM-3A

$26.95

HIGH FIDELITY FM TUNER KIT (FM-3A)

Featuring broad-banded circuits for full fidelity and better than 10 microvolt sensitivity for 20 db of quieting, the FM-3A pulls in stations with clarity and full volume. Incorporates stabilized temperature compensated oscillator, built-in power supply, pre-aligned IF transformers and ratio detector. The pre-assembled tuning unit is pre-aligned. Two output levels provided. Shpg. Wt. 8 lbs.

AUTOMATIC HI-FI RECORD CHANGER KIT (RP-3)

Combining automatic convenience with turntable quality through unique and simple design the Heathkit RP-3 handles your records with the finest of care for full fidelity reproduction. The unique "turntable pause" feature during change cycle and smooth friction clutch start prevents record damage. Proper weight distribution and low pivot point friction of the tone arm minimize arm resonance, tracking error, and record wear. All record changer kits come equipped with changer base, stylus pressure gauge, 45 RPM spindle, and necessary wire.

STEREO MODEL RP-3S: Equipped with Shure diamond stylus magnetic cartridge providing frequency response of ±4 db from 30 to 14,000 CPS. Shpg. Wt. 19 lbs. **$74.95**

MONAURAL MODEL RP-3-LP: (monaural microgroove recordings only): Equipped with Fairchild Magnetic diamond stylus cartridge. Shpg. Wt. 19 lbs. **$74.95**

MONAURAL MODEL RP-3: Features a GE VRII magnetic cartridge with diamond LP and sapphire 78 stylus. Shpg. Wt. 19 lbs. **$64.95**

SPECIFICATIONS—Operates from: 105-130 volts 60 cycles. Wow and Flutter: Less than 0.18% peak at 33-1/3 RPM. Turntable Speed: Accurate within ±2%. Change Cycle: Completed in 9 seconds. Dimensions: 13¼" wide x 12" deep, 5" above and 3" below mounting board. Motor Type: 4 Pole hum shielded. Type of Drive: Friction. Record Speeds: 4 speeds. Automatic and manual 33-1/3, 45, 78 RPM. Manual only—16 RPM. Variations in Tracking Force: Less than 0.9 gram from first record to tenth record. Controls: "ON-OFF" switch. Manual Reject. "Speedminder" (automatic speed selection and indexing). Manual speed selector (4 speed). Finish: Midnight Gray. Base: Maple (unfinished). Mounting Board: Birch (unfinished).

a complete line of monophonic and stereo

NEW from the HEATHKIT AUDIO LABS

HEATHKIT®

Hi-Fi Amplifiers

MODEL SA-3

NEW **$29.95**

NEW "ECONOMY" STEREO AMPLIFIER KIT (SA-3)

The all-new Heathkit SA-3 Stereo Amplifier has all the convenience of complete dual channel control at a fraction of the cost of comparable equipment. High level preamplifier section of the SA-3 provides complete control for both channels. Ganged tone controls provide "boost" and "cut" for base and treble. Dual concentric volume controls make possible precise channel balancing. A channel reversing switch and a speaker phasing switch allows optimum performance. Two separate inputs are provided for each channel to accommodate ceramic cartridge phonographs, AM-FM tuners, or tape recorder. Program source may be reproduced in either monophonic or stereo form. A really big package of stereo performance for the small investment! Shpg. Wt. 13 lbs.

SPECIFICATIONS: Power Output: 3 watts per channel, Utility Rating. **Power Response:** ± 1 db 60 cps to 20 kc at 3 watts output. **Total Harmonic Distortion:** less than 3% 60 cps to 20 kc at 3 watts output. **Intermodulation Distortion:** less than 3% at 3 watts output using 60 cycle and 6 kc signal mixed 4:1. **Hum and Noise:** 65 db below full output. **Controls:** dual clutched volume, ganged treble, ganged bass, 7 position selector, speaker phasing switch, on-off switch. **Inputs:** (each channel) tuner, crystal or ceramic phono. **Outputs:** (each channel) 4, 8, and 16 ohms. **Finish:** black with gold trim. **Dimensions:** 12½" W. x 6¾" D. x 3¼" H.

MODEL EA-1

NEW **$15.95**

NEW "ECONOMY" 3 WATT AMPLIFIER KIT (EA-1)

More than enough for room filling volume . . . ideal for getting started on a low cost individual component system. Designed for use with ceramic cartridge record players, tuners, tape recorders, etc. Built-in preamplifier provides you with all the necessary tone and volume controls for adjusting the sound reproduction to your personal taste. Smart appearance, quality components, assemble it in a few hours for years of trouble-free enjoyment. Shpg. Wt. 7 lbs.

SPECIFICATIONS: Power Output: 3 watts. Utility Rating. **Power Response:** ± 1 db 60 cps to 20 kc at 3 watts output. **Total Harmonic Distortion:** less than 3%, 60 cps to 20 kc at 3 watts output. **Intermodulation Distortion:** less than 3% at 3 watts output using 60 cps and 6 kc signal mixed 4:1. **Hum and Noise:** 70 db below full output. **Power Supply:** transformer operated full wave rectifier. **Inputs:** (2), crystal or ceramic phono cartridge, tuner. **Input Sensitivity:** 100 mv for 3 watts output. **Output Impedance:** 4, 8, and 16 ohms. **Dimensions:** 3¾" H. x 9¼" W. x 6" D.

MODEL EA-3

NEW **$29.95**

NEW 14-WATT HI-FI AMPLIFIER (EA-3)

From HEATHKIT audio labs comes an exciting new kit . . . New Styling, New Features, Brilliant Performance! Designed to function as the "heart" of your hi-fi system, the EA-3 combines the preamplifier and amplifier into one compact package. Providing a full 14 watts of high fidelity power, more than adequate for operating the average system, the EA-3 provides all the controls necessary for precise blending of musical reproduction to your individual taste. Clearly marked controls give you finger-tip command of bass and treble "boost" and "cut" action, switch selection of three separate inputs, "on-off" and volume control. A hum balance control is also provided.

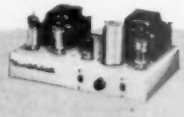
NOTE THESE OUTSTANDING SPECIFICATIONS: Power Output: 14 watts, Hi-Fi; 12 watts, Professional; 16 watts, Utility. **Power Response:** ± 1 db from 20 cps to 20 kc at 14 watts output. **Total Harmonic Distortion:** less than 2%, 30 cps to 15 kc at 14 watts output. **Intermodulation Distortion:** less than 1% at 16 watts output using 60 cps and 6 kc signal mixed 4:1. **Hum and Noise:** mag. phono input, 47 db below 14 watts; tuner and crystal phono, 63 db below 14 watts.

PREAMPLIFIERS

Model WA-P2 "Master Control" hi-fi preamplifier kit. 7 lbs. **$19.75**
Model SP-2 Mono-Stereo (2 channel mixer) Preamplifier kit. 15 lbs. **$56.95**
Model SP-1 Single Channel version of SP-2. 13 lbs. **$37.95**
Model C-SP-1 Converts SP-1 to SP-2. 5 lbs. **$21.95**

HEATHKIT®

POWER AMPLIFIERS



Model UA-1 "Universal" hi-fi 12-watt amplifier kit. 13 lbs. **$21.95**
Model W-4AM Single Chassis 20-watt hi-fi amplifier kit. 26 lbs. **$39.75**
Model W-3AM Dual Chassis hi-fi 20-watt amplifier kit. 29 lbs. **$49.75**
Model W-7M "Extra Performance" hi-fi 55-watt amplifier kit. 26 lbs. **$54.95**
Model W-5M high fidelity 25-watt amplifier kit. 31 lbs. **$59.75**
Model W-6M high fidelity 70-watt amplifier kit. 52 lbs. **$109.95**

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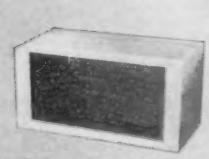

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HEATH COMPANY, Benton Harbor, Michigan

a subsidiary of Daystrom, Inc.

NEW: Heath Now Puts 2-Way Radiotelephone Communications in Reach of Everyone

Citizen's Band Transceiver Kit

NEW: No Radio Operators License Necessary!

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- Any U.S. citizen 18 or older eligible for license.
- No theory to study—no tests to take.
- Hundreds of uses in business or pleasure.
- Top quality components—proven performance—easy to build.

SPECIFY FREQUENCY CHOICE

CLASS D CITIZEN'S BAND FREQUENCIES

26.965 mc	27.035 mc	27.115 mc	27.185 mc
26.975 mc	27.055 mc	27.125 mc	27.205 mc
26.985 mc	27.065 mc	27.135 mc	27.215 mc
27.005 mc	27.075 mc	27.155 mc	27.225 mc
27.015 mc	27.085 mc	27.165 mc	*27.255 mc
27.025 mc	27.105 mc	27.175 mc	

*This channel shared with Class C Radio Control.

NEW

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Includes transceiver, microphone, and special power cords.

$42.95

First and only kit of its kind . . . designed to meet all FCC requirements for two-way radio telephone communication on new class D 11-meter "citizens band" . . . any U.S. citizen eighteen or older eligible for license . . . no code test, no radio theory exams, no knowledge of specialized operating procedures required . . . just fill out simple form included with kit and mail to FCC for registration. The Heathkit CB-1 Transceiver is light, compact, simple to assemble, easy to use. Buy two or more units, have your own communications system . . . talk with family, friends, associates from your car, home, boat or office . . . cover distances from one to ten miles depending on location and type of installation (extensively field tested). A flick of a switch selects "transmit" or "receive" while single receiver tuning control selects any of 23 assigned channels . . . third knob controls volume and turns set on and off. With separate vibrator power supply available from Heath, along with two special power cords included with kit, you can convert transceiver from fixed location at home or office to mobile operation in cars, boats, etc., in minutes, after initial installation, with no tools or adjustments. There's a Heathkit accessory antenna for any application, mobile or fixed. Kit comes complete with microphone, station identification card which fits in plastic window at end of cabinet, all pertinent FCC regulations and application forms, a sheet of adhesive-back letters and numbers to affix call letters in space provided on front panel, and crystal for one channel. Specify your frequency choice or we will supply crystal of appropriate frequency. The famous Heathkit quality coupled with the market-shattering low price of this kit make it truly a value of a lifetime. Shpg. Wt. 10 lbs.

SPECIFICATIONS—Receiver Type: Superregenerative detector w/rf stage. Power Input: 5 watts to plate of final RF amplifier (FCC maximum). Transmitter Frequency Control: Third overtone type quartz crystal operating within 0.005% of marked channel frequency between 32 F and 140 F. Modulation: AM plate modulation automatically limited to less than 100% (FCC requirements). Power Supply: 117 V 50/60 cycle, AC. 6 V battery using Model VP-1-6 Vibrator Power Supply or 12 V battery using Heathkit VP-1-12. Power Requirements: 117 volts 50/60 cycle AC 35 watts; 6 V battery w/VP-1-6, 6.5 amps., 12 V battery w/VP-1-12, 4.0 amps. Total B + requirements, 260 volts at 60 ma; total heater requirements, 6.3 volts at 1.8 amps. or 12.6 volts at 0.9 amps. Power Rectifier: 2 silicon diodes in full wave voltage doubler circuit. Microphone: Combination hand-held and desk type, ceramic element, plastic case, with cord and connector. RF Output Impedance: 50 ohms. Speaker Size: 4 inch (round). Undistorted Audio Power Output: Approximately 1 watt. Line Cords: Two supplied, one for AC operation, one for battery operation. Power circuits automatically switched when appropriate line cord is plugged in. Cabinet Dimensions: 8" H. x 6" D. x 9¾" W.

ANTENNAS

MODEL CBU-1 "UTILITY" ANTENNA

Low cost, portable antenna for CB-1 Transceiver for temporary installations, mobile or fixed, where maximum coverage is not required. Rugged clip for mounting on eaves-trough of house or rain gutters of cars, trucks, etc. Bracket supplied for mounting on transceiver or any flat surface. 45½" base-loaded, antenna with 12' connecting cable comes complete, ready to use. Shpg. Wt. 3 lbs.

$9.95

MODEL CBM-1 "MOBILE" ANTENNA

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$19.95

MODEL CBF-1 "FIXED LOCATION" ANTENNA

A ¼ wave "ground plane" type antenna for CB-1 Transceiver using 4 radial elements as the "ground plane" and 1 vertical element as the radiator. Excellent coverage, essentially non-directional, making it ideal for communications between fixed and mobile units. Antenna measures 9' 4" from bottom of mounting bracket to top of vertical radiator. Radial length 9'. Kit is complete with 50' connecting cable and easy to install mounting clamp. Shpg. Wt. 7 lbs. **$19.95**

POWER SUPPLIES FOR MOBILE USE OF CB-1:

MODEL VP-1-6 Vibrator Power Supply kit for 6 volt batteries. Shpg. Wt. 4 lbs.

$7.95

Model VP-1-12 Vibrator Power Supply kit for 12 volt batteries. Shpg. Wt. 4 lbs.

$7.95

NEW

MODEL CO-1

$7.95

(batteries included)

NEW TRANSISTOR CODE PRACTICE OSCILLATOR KIT (CO-1)

Your best buy in a high quality code oscillator, the CO-1 is ideal for Boy Scouts or beginning radio hams. Practice code by authentic CW tone or blinker light. Switch selects built-in speaker or light. Contactor provided for practice keying or any standard key can be connected. Completely transistorized for long battery life. Powered by two standard flashlight batteries. Batteries included. Shpg. Wt. 3 lbs.

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Model BT-1 Battery Tester kit. . .2 lbs. **$8.50**
Model ET-1 Enlarger Timer kit. . .3 lbs. **$11.50**
Model BR-2 Broadcast-Band Receiver kit. .10 lbs. . .(less cab.). . **$18.95**
Model RC-1 Professional Radiation Counter kit. . .8 lbs. **$79.95**

MODEL XR-1P

MARINE KITS . . .

For Fun and Safety Afloat

Model DF-2 Two Band Transistor Radio Direction Finder kit 9 lbs. **$69.95**
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Model MC-1 Marine Battery Charge kit. . .16 lbs. **$39.95**
Model PC-1 Power Converter kit. . .8 lbs. **$24.95**

MODEL DF-2

NEW
from Heath Test Equipment Labs

New—Electronic Ignition Analyzer Kit—IA-1A

MODEL IA-1A
$59.95

- A Fraction of the Cost of Comparable Instruments
- Shows "Picture" of Entire Ignition System Performance on Cathode Ray Screen
- Shows Primary or Secondary Circuit Patterns
- "Trouble-Shoot" Complicated Ignition Faults in Minutes

A revolutionary development in the automotive tune-up field. Heathkit offers the small garage owner, service station operator or hobbyist an ignition analyzer with qualities and features of scopes costing several times as much (comparable to instruments costing as much as$750.00). The savings you realize through do-it-yourself kit assembly are only part of the story. Heath engineering know-how and tremendous buying power play an important role in keeping prices at rock bottom. Yet, this scope, as with all Heathkits, is designed to be "beginner built". A few hours of your spare time . . . and you're in business. The IA-1A lets you check the complete ignition system of an automobile in operation by merely connecting two leads to observe the tell-tale spark pattern of the cylinders. Can be used with the car under load and in motion by adding a vibrator power supply. Shows condition of coil, condenser, points, plugs and ignition wiring. A switch selects either primary or secondary circuit patterns; or alternately provides choice of parade or superimposed secondary patterns. It will also indicate coil reserve, a poor spark plug, defective wiring and will even identify the offending plug or wire. Also detects breaker point bounce, a defective condenser, or will allow setting of the dwell-time of the points. The IA-1A is simple to use, with a minimum of controls, yet is completely flexible for all types of internal combustion engines with coil ignition and accessible breaker points. Shows complete engine cycle or just one cylinder at a time. Test leads and comprehensive instruction manuals are supplied with kit. Shpg. Wt. 20 lbs.

NEW MODIFICATION KIT FOR OWNERS OF MODEL IA-1 IGNITION ANALYZERS:
Gives you switch selection of either primary or secondary circuit patterns; or alternately provides choice of parade or superimposed secondary patterns. Kit includes test lead modification parts and comprehensive instructions for modification and use. Shpg. Wt. 2 lbs. Heathkit MK-6. **$4.95.**

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NEW EDUCATIONAL ELECTRONIC ANALOG COMPUTER KIT (EC-1)

- 9 DC operational amplifiers—3 initial condition power supplies
- 5 coefficient potentiometers—repetitive solution oscillator
- Electronically regulated power supply

NEW from the HEATHKIT INSTRUMENT LABORATORIES

HEATHKIT EC-1

$199.95

Filling a multitude of needs in the fields of education and electronics, the model EC-1 puts advanced engineering techniques within easy reach of the average individual or institution. An assortment of precision components and patch cords are provided for setting up many complex problems. Solutions are read directly on the panel mounted meter or on an external read-out device such as the Heathkit OR-1 DC Oscilloscope. An informative manual is provided, illustrating operating procedures and basic computer information as well as showing how to set up and solve typical problems. Shpg. Wt. 43 lbs.

NEW 5" DC OSCILLOSCOPE KIT (OR-1)

- Identical DC coupled vertical and horizontal amplifiers
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- Transformer operated silicon diode power supply

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Offering all the features of a high quality DC oscilloscope, the model OR-1 is ideal as a read-out indicator in computer applications as well as many types of testing and development work. Features DC to 200 kc (1 db point) bandwidth, 0.1 V (peak-to-peak) per CM sensitivity (uncalibrated). Normal frequency coverage is from 5 to 50 kc in four overlapping ranges. Critical voltages are regulated with gas-filled VR tubes. Coupling may be either AC or DC as selected by the input attenuator switch. Many uses in industrial, educational and medical fields. Shpg. Wt. 21 lbs.

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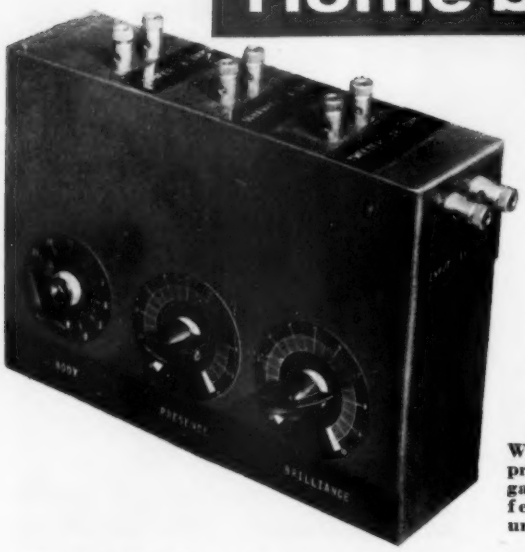
Home-built Professional CROSSOVER

An interesting three-way crossover built to match almost any speaker system

By DR. A. H. FRY



When installed in a properly finished cigar box, a real professional-looking unit is what you get.

LIKE everything else in hi fi, good professional-grade crossover networks can make a big dent in anyone's pocketbook. However, neatly packaged networks for your favorite crossover frequencies and voice-coil impedances can be handsomely, accurately and inexpensively made at home—even on the kitchen table and using only ordinary tools.

The trick lies in winding the coils without a lathe and in packaging them (along with the capacitors and attenuators) in a nonmetallic container.

The first job is to calculate the necessary values. This is easy. Find out, from any handy reference book or nomograph,[1] the inductance and capacitance required for the crossover you want, then how many turns, what size wire and what size core give the required inductance for a specific crossover frequency and voice-coil impedance. This can also be obtained from readily available literature.[2] Capacitors are also specified (in the nomograph) to give the correct L-C combinations.

The second is finding the simplest way to get the wire on the form and deciding what to use for a form. A trip to the hardware store reveals that wooden window-shade rollers come in various diameters. Purchase one of the right diameter and cut a piece to the required length. This gives you a nonmetallic core with a lengthwise hole through it. Just the thing! While still at the hardware store, fit the hollow wooden core with a 3/16 x 4-inch bolt. See Fig. 1.

Cut the washers that form the coil ends from a scrap of Masonite but be sure to drill a hole in the center for the bolt. Next, get the old hand brace and put one end of the core assembly in its chuck. Now, clamp the jig (see Fig. 2) (cut out of a ⅛-inch piece of scrap brass) into a vise and stick the bolt-head end of the assembly into the V cut in the jig. With the core in place, make a small hole in the Masonite pancake, near the roller, with an awl. This gives you a place to poke

[1] N. H. Crowhurst, "High-Fidelity Circuit Design," Gernsback Library, No. 56.

[2] "High-Fidelity Design, Construction, Measurements," Gernsback Library No. 48. A. Cohen, "Hi-Fi Loudspeakers and Enclosures," John F. Rider, 1956.

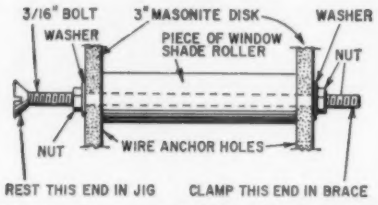


Fig. 1—Core assembly for the two coils.

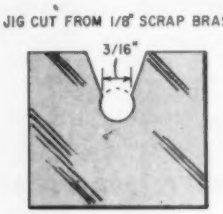


Fig. 2—The jig that holds one coil end during the winding procedure.

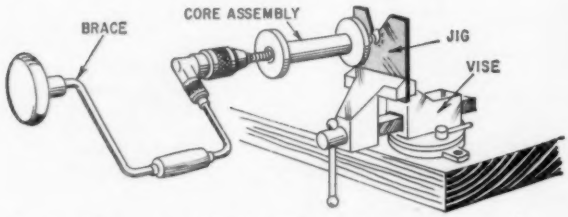


Fig. 3—this setup, with the XYL's help circumvents the need for a lathe when winding coils.

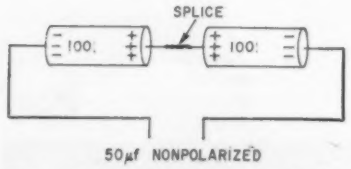


Fig. 4—Two 100-μf electrolytics connected as shown form a 50-μf nonpolarized unit.

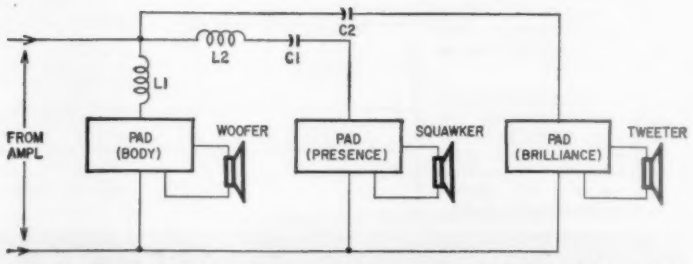


Fig. 5—Basic circuit of 3-way, 6-db-per-octave network. (Values of L and C are determined by choice of crossover frequency, voice-coil impedance and output transformer secondary.)

the wire through. Use it as a starting place.

The most difficult part of the operation is right here, where you have to get the XYL to put on a pair of canvass gloves and feed the wire from the spool tightly and neatly, layer upon layer, while you turn the brace (see Fig. 3). It takes only a few minutes to wind as many as 500 turns. After you've wound the needed turns, cut the wire and stick the loose end through a hole in the outer edge of the nearest Masonite washer.

Here comes the important stage: how do you get the Masonite disks off the ends without the whole shebang going ka-pflooey? It's simple. The wire stays in place when wound tightly. Wrap the finished inductor very tightly with plastic tape—round and round. Next, loosen the nuts, carefully remove the bolt and disks and hold the inductor like a doughnut between your thumb and index fingers. Have the XYL wrap the inductor transversely with more plastic tape, until it looks like a fat little doughnut wound up like a mummy.

Now you are ready to finish the crossover. For large-value capacitors (values specified by the nomograph), use ac induction-motor starting capacitors. They come in all shapes and sizes and are nonpolarized. For small-value capacitors, use noninductive paper types.

Nonpolarized capacitors are important since speech and music are alternating current. If your electrical supply house does not have these, use low-voltage electrolytics back to back (see Fig. 4). This hookup makes the combination nonpolarized, as required, although it cuts the capacitance value of the individual units in two, of course.

Attenuators, in the form of L-pads, T-pads or potentiometers, are used to adjust the audio level to the loudspeakers. A typical arrangement of this type is shown in Fig. 5.

Matching a 16-ohm input to a 8-ohm woofer, a 4-ohm squawker, and a 16-ohm tweeter (as in the photo) may seem unlikely, but by setting the pads properly a balanced and effectively matched output was obtained.

Last, get a cigar box. This makes a perfect housing. It isn't metallic, it's free and it is easy to drill for binding posts and attenuator shafts. To give it a professional appearance, cover it with Con-Tact (also from the hardware store). To give it an even more professional appearance, use bakelite name plates (the kind used under doorbells in apartment houses) marked WOOFER, TWEETER, SQUAWKER, INPUT, OUTPUT. These cost less than 25c each to be made up. They really dress up the dressed-up cigar box. Glue them near the appropriate binding posts and dials.

Total cost of a three-way tailor-made crossover—binding posts, attenuator pads, wire, capacitors, name plates etc.—should run from $10–$15. Construction takes one evening. END

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Convenient "over-the-counter" delivery is now available through any of the Authorized Heathkit Dealers listed below. Although you will find the price of Heathkits slightly higher when buying locally, we're sure you'll agree that this increase is justified. Your dealer absorbs all transportation charges, carries a complete stock of kits for immediate delivery, provides demonstration facilities, offers you a reliable source for parts and fast service . . . and stands ready to counsel or advise you on any problem that might arise.

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Dunlap Radio & TV
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639 National
ONTARIO
Kiesub Corporation
124 N. Benson
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Zack Electronics
654 High Street
SACRAMENTO
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MULTI-IMPEDANCE TRANSISTOR AMPLIFIER

By HAROLD REED

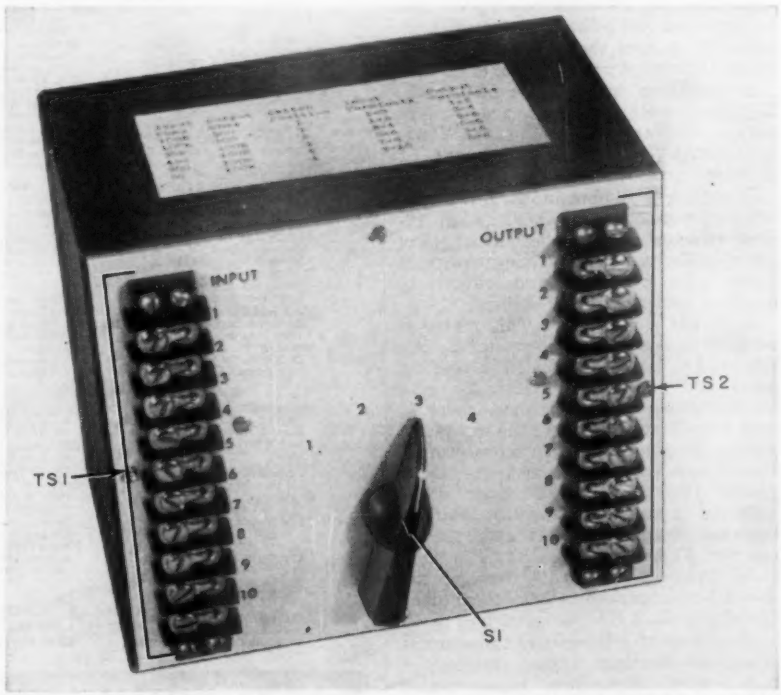
EXPERIMENTING with transistors is one of the most fascinating hobbies for the serious-minded electronics worker. I find it so and am continually looking for ways to conduct numerous tests and experiments quickly and easily. With this in mind, I realized that, if a flexible amplifier were kept on hand, it could be used in many experimental circuits and test procedures along with other transistor or electron-tube circuitry. The amplifier might also be used as the front end of a permanent audio system using any or all of the input and output arrangements, as required in a specific application. The outcome of this idea is shown in the diagram.

The circuit provides low-, medium- and high-impedance inputs and low and high output impedance. The input circuits can be used for low- or high-impedance microphones, carbon microphone with external battery, magnetic pickups, close match for 500/600-ohm line sources, bridging for terminated 500/600-ohm line and coupling to other transistor apparatus. The output circuits would be suitable for working into the input grid of an electron-tube amplifier, feeding a 500/600-ohm line and working into other transistor equipment. No doubt the reader will think of many other uses for the device.

The amplifier is built around circuit configurations suggested by Sylvania for their 2N35 n-p-n junction transistor. Combining several circuit arrangements, adding switching facilities and including two small tapped transformers produced a one-transistor unit with extreme versatility.

Construction details

The photograph shows the unit in its metal cabinet. It is 4 x 5 x 6 inches and was used because it happened to be on hand and would also allow for expansion. Physically, the device could be made much smaller, but this seems to serve no particular purpose. Also, since the unit was built with convenience and utility in mind rather than appearance, everything necessary for its operation is mounted on the front panel. In this way the unit can be used upright as shown or on its back and all required operating items are conveniently available. A shelf is attached to the rear of the panel for mounting other necessary parts. Parts placement is noncritical except for keeping input and output transformers and wiring as far apart as possible. Input and output wiring should be as short as possible and dressed with no closely spaced parallel leads.



Switch positions and input and output terminals are identified by the card glued to the top of the amplifier case.

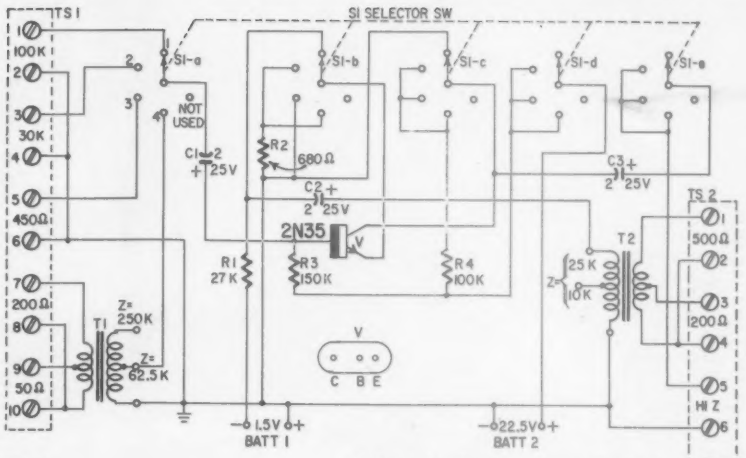
Table of Amplifier Characteristics

Input (ohms)	Output (ohms)	Switch Position	Input Terminals	Output Terminals
100,000	500	1	1–2	1–2
100,000	200	1	1–2	3–4
30,000	100,000	2	3–4	5–6
450	100,000	3	5–6	5–6
200	100,000	4	7–8	5–6
50	100,000	4	9–10	5–6

Rather than put all pertinent information on the panel, the selector switch positions and input and output terminals are assigned numbers and a card with data corresponding to these numerals is cemented to the top of the metal cabinet. The information contained on this card is given in the table. The output terminal strip has four spare terminals.

Amplifier circuits

Now for an analysis of the circuit. Position 1 of selector switch S1 provides a common-collector audio amplifier circuit. The common-collector transistor arrangements result in a circuit similar to an electron-tube cathode follower; that is, high input impedance and relatively low output impedance, with voltage gain less than 1 and no signal phase reversal. No dc bias to the base and low collector voltage—BATT 1, 1.5 volts—contribute to high input impedance, which is about 100,000 ohms. Voltage gain is approximately 0.95. The output circuit consists of the 25,000-ohm primary of transformer T2, whose secondary furnishes a 500- or 200-ohm output. T2 also includes a 10,000-ohm tap, not connected in this circuit, which can be useful in experimental work.



R1—27,000 ohms
R2—680 ohms
R3—150,000 ohms
R4—100,000 ohms
All resistors ½-watt 10%
C1, 2, 3—2 μf, 25 volts, miniature electrolytics
BATT 1—1.5 volts (Burgess Type N or equivalent)
BATT 2—22.5 volts (Burgess Type U15 or equivalent)
S—6 poles, 5 positions, miniature rotary (1 pole not used) (Centralab miniature PA-1021 or equivalent)
T1—input transformer: primary, 50 and ; secondary, 62,500 and 250,000 ohms (1 or equivalent)
T2—plate-to-line transformer: primary, 1 25,000 ohms; secondary 200 and 500 o SO-3 or equivalent)
TS1, 2—10 terminal, screw type, barrier strips
V—2N35
Case, 4 x 5 x 6 inches
Miscellaneous hardware

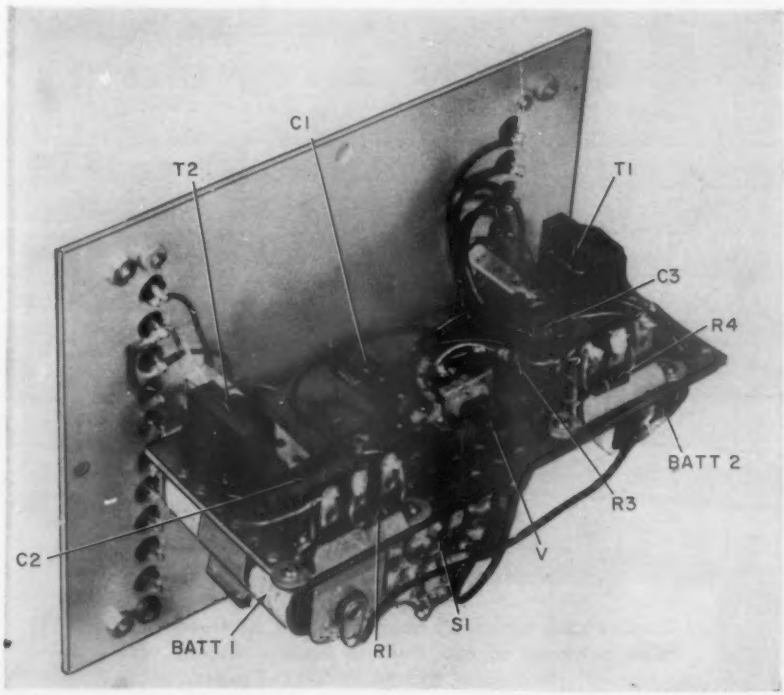
Circuit of the 1-transistor unit.

Position 2 of the selector switch sets the circuit up for common-emitter operation. In this case, series resistor R2 included in the emitter leg results in degeneration. Degeneration effectively increases the input impedance over the common-emitter circuit without degeneration. Input impedance in this switch position is 30,000 ohms. Output impedance is high, suitable for working into high-Z circuits. BATT 2, 22.5 volts, now supplies the dc potential. Voltage gain is in the order of 100.

With the selector switch thrown to position 3, a common-emitter circuit without degeneration is provided. Note that the 680-ohm emitter resistor R2 is not included in the circuit. Input impedance is low, about 450 ohms, output impedance is high, 100,000 ohms, and voltage gain is high, between 300 and 400. BATT 2 is again the dc supply source.

Selector switch position 4 provides the same common-emitter circuit with degeneration as did switch position 2. However, this time transformer T1 comes into the circuit. Its secondary-winding tap of 62,500 ohms works into the medium-impedance input of the transistor. T1's primary provides low-Z inputs of 50 and 200 ohms. Its secondary also offers a 250,000-ohm impedance, not wired in, which will often prove useful. High Z is provided in the output. Gain will be the same in switch position 4 as for position 2, plus the voltage gain provided by the turns ratio of transformer T1, which of course, depends on the winding taps used.

Other wiring arrangements will be visualized by the reader and can be incorporated to suit his personal requirements. The two unused transformer taps are suitable for many transistor circuits and may be used to good advantage. The device, of course, may be expanded further by employing the extra, unused pole and contact position on the switch specified. Also, switches with a greater number of poles and contact positions are available. The arrangement described here gave as much flexibility as I desired. END



Inside view shows phenolic chassis board and suggested layout.

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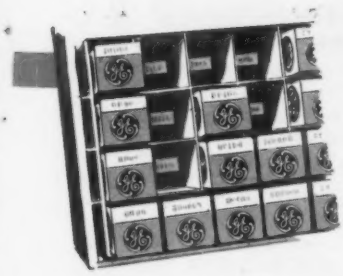
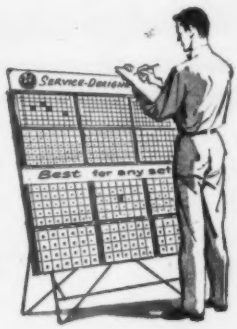


Missing cartons show what tube types you should reorder.



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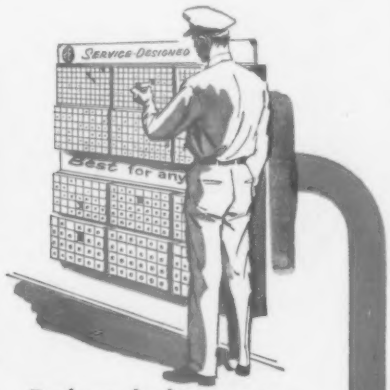

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ALL ABOUT THE REFLEX ENCLOSURE

Part VII—*More on Q and damping; the speaker location; checking the response*

By P. G. A. H. VOIGT

WHEN the Q is reduced by friction or deliberate damping (as described last month), sound energy is turned into heat. To turn energy into sound waves seems much more desirable, but this is not necessarily so. In a good sound-reproducing system, the various frequency ranges should be in balance, and there should be no serious peaks. Peaks depend largely on the speaker, but the type of amplifier used is involved. So are the room acoustics (which cannot be discussed now). Even the position of the speaker in the room has an important effect.

We already know that the amplifier's output impedance affects the magnetic damping and in turn the behavior on transients. The output impedance also has a direct effect on the response of sustained notes. If the amplifier has a high output impedance, such as that from a pentode without feedback, it tends to operate on a "constant-current" basis, and forces current through the voice coil regardless of any back voltage generated. The impedance curve (with its peaks) is then an indication of the voltage applied to the coil. Since power is volts × amps (when they are in phase, as happens on the peaks), maximum power is supplied to the voice coil just at the peaks when it is least required.

On the other hand, if the input impedance is small compared to the dc resistance of the voice coil, we have operation close to a "constant-voltage" basis. Then the current *drops* when the impedance rises, so input power goes down just at the right places. Normally, it does not go down enough for complete compensation, but at least it does change in the right direction.

"Variable-damping" controls

In amplifiers with so-called variable damping, a control alters the effective output impedance. Therefore, while it alters the damping it *also* alters the effective response of any system that does not have a flat speaker impedance curve. If speakers had level impedance curves, response would not change as the input impedance is varied, and the control would alter only the damping. Though some speakers have very level impedance curves, the majority do not. An impedance change of 5 to 1 over the scale is nothing unusual. Very considerable response changes can therefore be expected when adjusting the so-called damping control.

Any control which changes two things at once, I regard as treacherous, for what may seem to be a beneficial change one way can cause unnoticed damage in another. In this particular case, the control setting which increases the input impedance will, with most speakers, raise the treble and bass response at the reflex peak frequencies. Simultaneously, it will diminish the magnetic damping. The bass is therefore peaky and the bass transients become unnatural. I prefer maximum damping at all times, so I use the bass-boost control when more bass is needed. The boost provided by a good bass-boost circuit is aperiodic.

The corner location

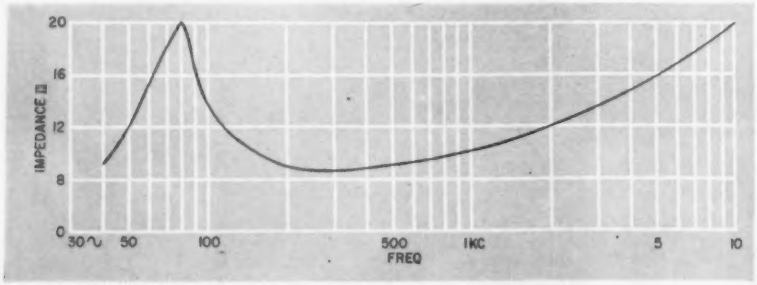
The room affects matters in two ways: by its own reverberation response when reflecting sound and by the way it affects the direct (immediate) loading on the speaker system. Such loading was discussed in Part V, and standing the speaker in a corner is always well worth trying.

The increased loading that this position usually gives at low frequencies is a much better way of boosting the bass than any other, for it *adds* to the damping, diminishing Q and hangover. In rare cases, the experiment does not work. Usually, in those, what looks like the room wall is but a flimsy, freely vibrating partition, too light to confine the low frequencies properly. If a room has more than one corner which is practical, try alternative corners, for there is often a very marked difference between the results from different corners. The one with the most solid walls is usually the best, and helps to raise the bass substantially.

Every room has its own reflections and internal stationary waves (also called *eigentones*—from the German word). These usually help but occasionally hinder the corner location. It has been argued that a corner location is undesirable since from it the speaker sets up more of the room's eigentones than from the normal position. While this is true, the argument tends to overlook the fact that the wall-to-wall dimensions of a room are much larger than those of a cabinet and also that the room has a much greater volume. In consequence, it takes a relatively long time to set up the eigentones of a room. The reverberation time of a room is usually of the order of 1 second.

The rapid bass modulation, which is

Generalized speaker impedance curve. Peaks may be greater than shown here. An impedance change of 5 to 1 is not unusual.



the low-frequency transient we want to preserve, occurs so much faster than this that the room does not react quickly enough. The concentration due to the corner position is effective as the sound leaves the speaker during the initial transit across the room, and is therefore independent of room reverberation. If room eigentones increase or reduce the loading at various frequencies, those irregularities will become effective only when the frequencies concerned have persisted long enough to build up the room reaction.

The direct sound is thus more faithful and this improvement exceeds any deterioration due to such extra room eigentones as might arise because the corner has been used. The basic effect of eigentones in any case does not differ materially from the effect of working in a different room which happens to be more lively acoustically.

The important thing to remember is that the corner position helps the low frequencies by making the speaker system work into a greater load, thus improving the efficiency as well as reducing speaker hangover.

If a speaker system has a certain overall efficiency in the middle and upper ranges, and the efficiency of the low frequencies is raised too much by the corner location or otherwise, the general effect may become "bass heavy," especially in rooms which tend that way because of excessive absorption by furnishings, etc. Such an unbalanced effect can be counteracted by adding frictional absorption, thus cutting down the excess bass. When we bear in mind that this will lower still further, the Q of any resonances, and so diminish peaks in the audio response, as well as cutting short any hangover, the advantages will be very obvious.

Checking the response

Some persons who go often to concerts in various halls can carry a mental standard of the average balance between the various parts of the scale under "live" conditions. Another good test, especially of the main range, is the sound of the male speaking voice. The scientific way of testing whether the various frequencies are in balance is, of course, by measurement.

Measuring the voice-coil impedance curve, which is relatively easy, unfortunately gives no true index of the sound output. At high frequencies, the coil's inductance usually produces a high impedance quite regardless of whether the coil moves. At lower frequencies the impedance does depend in part on the velocity of the coil vibration and so gives much useful information. But it is measured under conditions which normally differ considerably from those which are effective when the speaker is used for its proper purpose. Even when the coil velocity is known from the impedance curve, the energy radiated from the cone depends upon the load, and that varies tremendously across the scale. Cone breakup

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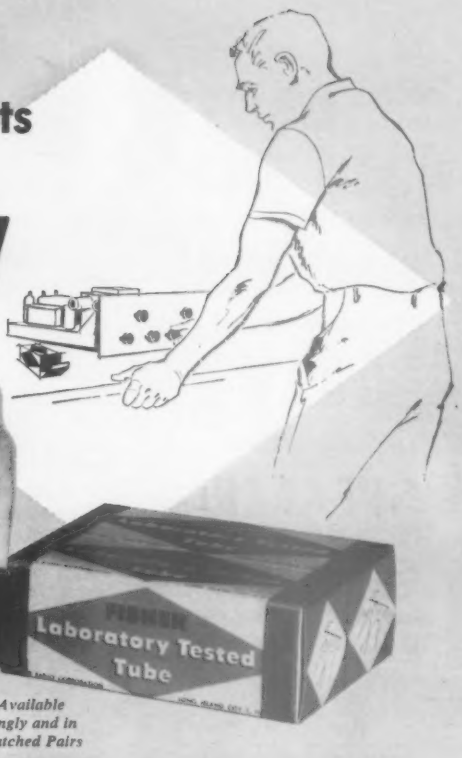

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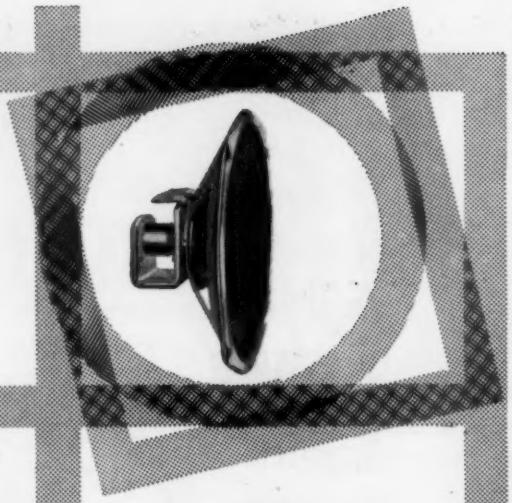

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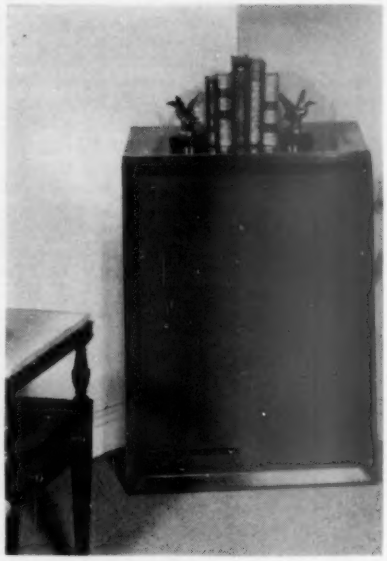

Corner location increases speaker loading and lowers the Q.

adds to the complications, and there is radiation from the port, also perhaps from the cabinet walls if they vibrate at all (which they nearly always do very slightly).

The only proper way, therefore, is to calibrate the system on site under its own working conditions. Unfortunately, such calibration is difficult to interpret because it is normally made with sustained tones which persist long enough to set up the stationary waves of the room. Normal calibration methods tell little about speaker hangover and, in any case, few people have access to the necessary equipment.

The owner's ear is therefore usually the final judge. And if, perchance, the balance he prefers differs from what you like, that is not something you are really in a position to argue about—unless direct comparison with the original is possible as, for example, with a monitoring system alongside a broadcasting studio. On your own equipment, in the absence of direct comparison, if you are alone, don't you also adjust the controls to give the balance you prefer?

Artificial damping

We can now summarize the subject of damping the Q of simple reflex systems. To start with, a good speaker is a good investment because the electromagnetic damping on its own moving parts is better and so it has a flatter response. Therefore, it allows the use of a bigger air-volume cabinet with a naturally lower Q. Both speaker and air volume have reduced hangover, thus making the system more nearly aperiodic in operation.

Next, the reflex system is, by nature a resonant system with two of its resonances at frequencies corresponding to those of the peaks in the impedance curve. Under working conditions, these frequencies (especially the upper

one) are damped electromagnetically by the speaker and mechanically by the work load, but as a rule much more damping is needed to flatten the response. Any such damping (artificial damping) causes the efficiency to drop. That may be undesirable, especially if the amplifier doesn't have much reserve.

When efficiency is high enough to permit a lowering at either peak, damping material of the type which the sound passes through is appropriate. If placed across the port, it controls the lower peak directly and the upper peak to a lesser extent. If placed at the speaker, it controls the upper peak directly and the lower one indirectly. When the Q is damped down by absorption, the efficiency is reduced and more watts may be needed, *but* the low-frequency transients are improved, and so these become more lifelike.

By using the corner position, low-frequency efficiency can usually be improved and the Q damped down at the same time. Both the corner location and simultaneously damping down Q by additional friction are in order. Both reduce hangover and help approach aperiodic working conditions.

Any stationary waves inside the cabinet which cause serious trouble can usually be detected by the irregularities which they cause in the impedance curve. Their frequency and wavelength can thus be established, and by comparison with the cabinet dimensions the air vibration mode can be deduced. (Check that it is not a fault of the speaker itself—such faults should show in the free-air curve.)

After tracing the offending stationary wave, it can be damped down by damping curtains across the sound path at the regions of maximum velocity or be absorbed by thick layers at its pressure regions on the inside walls. The latter type is usually easier to apply, but both methods can be used together for maximum effect.

It is probably not necessary to line all the inside walls, especially with the larger cabinets, but such lining does no harm and makes sure that no important surface has been overlooked. In a well designed cabinet which avoids stationary waves as much as possible, a damping layer at the top and bottom and a belt inside the back and sides at about speaker height should be enough. But if prominent stationary-wave groupings are encouraged by unsuitable dimensioning, then the damping needed may have to be very drastic indeed.

Mr. Briggs, in one of his hilarious moments, offered to fill a cabinet with Shredded Wheat if that should be necessary to get sufficient damping. I have heard quite acceptable sound from large, properly designed cabinets with no internal anti-stationary wave damping at all. I doubt, therefore, if the drastic scheme he suggested will be necessary—certainly not with one of his own designs. But I must write Mr. Briggs one of these days and tell him about mice!

TO BE CONTINUED

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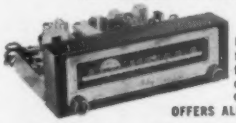

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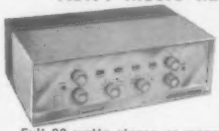

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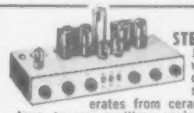

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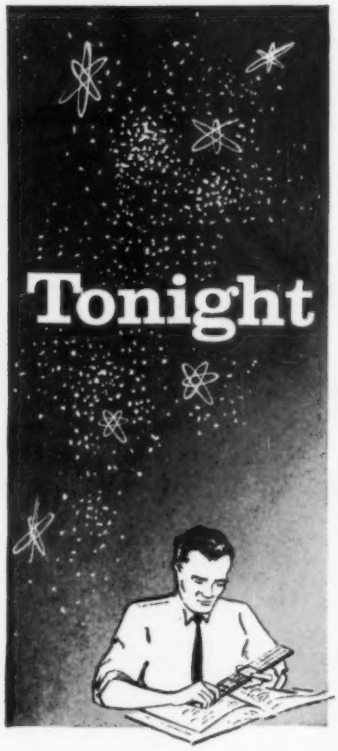

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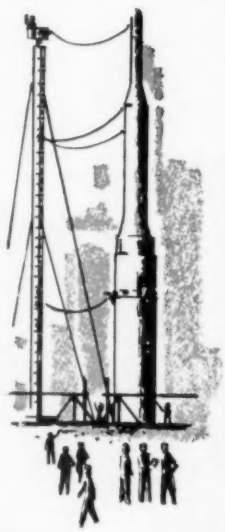

Paul S. Lewis, Jr., a research assistant in an AEC-sponsored nuclear physics research program — and a CREI student — writes, "Like most large-scale physics projects, this machine (a proton accelerator) is largely electronic. The need for electronics technicians on basic scientific research projects will no doubt continue to grow."

Charles E. Lawson, another CREI student, brings out another point: "The fact that I am enrolled with CREI caused enthusiasm on the part of my employer (Wright Airborne Electronics). A former student of CREI is now chief engineer for the company."

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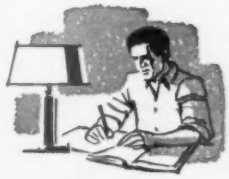

CREI STUDENTS are professional electronics engineers and technicians, all over the world and in every phase of electronics, about one-third military, the rest civilian. Their median age is 28. Last year they devoted approximately 1,572,456 hours to 104,831 lesson texts, answered (and were individually graded upon) 1,048,310 searching questions and engineering problems. They studied electronics engineering technology—transistors, microwaves, forward scatter, computers, servomechanisms, radar, electronic navigational devices, and the entire field of modern electronics. New students enrolled during the year are on the missile ranges of Vandenburg AF Base and Cape Canaveral. They are at Alamagordo and China Lake, at SAC bases around the world. They are in the research laboratories and manufacturing plants where the latest electronic equipment is designed and produced. They maintain electronic equipment for United Air Lines, and Trans-Canada Air Lines. They share in electronics at All America Cables and Radio, Inc., and The Martin Co. They work for USIA (Voice of America) and Columbia Broadcasting System, for Gates Radio and Federal Electric, to name but a few. All of the firms mentioned offer their personnel CREI technical education under company plans. CREI men are found by the hundreds among field engineers of major electronic manufacturers. They're across the world and across the street. They're men you'll compete with — to gain or hold your place in the electronics profession.

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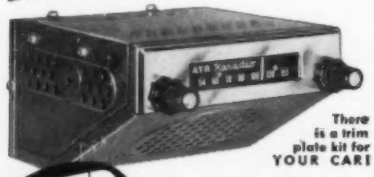

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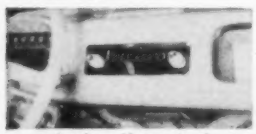

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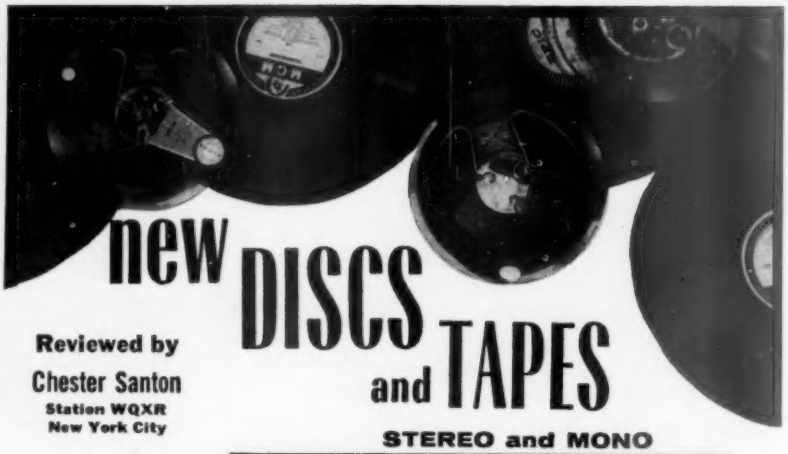

new DISCS and TAPES

STEREO and MONO

Reviewed by
Chester Santon
Station WQXR
New York City

VACATIONERS returning home this month should find stereo tapes actively attempting to regain the position they once held in the two-channel medium. Spearheading the drive will be the 7.5-ips, four-track, reel-to-reel tapes. The scope of the repertory in the new tape catalog is still unknown but the new narrower-gap playback heads promise improved high-frequency response. Work is also under way to reduce further the hiss level of the raw tape to maintain adequate signal-to-noise ratio. The opposing price structures of stereo tapes and discs are tentative at this time. In its latest guise, stereo tape may cost approximately $7 for a symphony that occupies both sides of an LP record. Disc manufacturers, however, still have room to maneuver when setting a competitive price. Now that some of the research costs have been covered, stereo discs could, if necessary, maintain a future price differential several dollars below that of tape. Some of the stereo discs reviewed this month could give a good account of themselves in the contest ahead.

Blood and Thunder Classics
Audiotape Bonus Package (Stereo)
(7-inch; playing time, 31 min.)

This ½-hour recorded reel of two-track tape (the mono version contains an hour of music) is available as a special offer. Acquired in conjunction with a blank reel of type 1251 Audiotape (1.5-mil acetate base), it adds only a dollar to the price of the two items. Noise level underlying the music is impressively low. The recording curve is uniform throughout the selections and is peaked to deliver a healthy quota of highs on the maximum number of machines. I found that response was smoothest with treble rolloff introduced around 7,000 cycles per second. The seven excerpts culled from familiar classics range from the light diversion of Tchaikowsky's *Nutcracker Suite* to a section of the choral movement of Beethoven's *Ninth Symphony*. Major emphasis is on the rousing repertory such as Falla's *Dance of Terror, The Saber Dance* by Khatchaturian and Stravinsky's *Firebird Suite*. The unidentified orchestras turn in performances that range from competent to nondescript.

Swingin' Standards
Buddy Bregman and His Orchestra
World Pacific Stereo Record 1024

This project rates the attention of the recording engineer and the advanced listener because two schools of stereo recording are represented on one record. World Pacific has miked the Buddy Bregman dance band in each of the American stereo techniques in use today. On Side 1 of the album we find the method favored by the listeners usually referred to as "purists" by people who disagree with them. This side contains the sound of a band of conventional proportions presented as it might be heard in a "live" ballroom performance. The sax section is in the front rank with the sound stretching from speaker to speaker. Trombones and trumpets occupy separate ranks behind the saxes. Soloists are heard in their normal environment within each section. The feature that makes this record unique lies in the following clever idea. Side 2 of the record offers the same mike placement in the same studio. This time the remaining standard tunes in the album are heard in the exaggerated ping-pong effect still encountered on many pop releases. Now the saxophone section is heard only on the left, and the brass section occupies an area from slightly left of center across to the extreme right. This is the first instance I've encountered where these two widely differing techniques can be evaluated under conditions of reasonable control.

RODGERS: *Victory at Sea, Vol. 1*
Robert Russell Bennett conducting RCA Victor Symphony Orchestra
RCA Victor Stereo Record LSC-2335

For the past 6 years, the first orchestral suite from the powerful score of the TV series, *Victory at Sea*, has been a consistent best seller. The original mono version featured outstanding audio quality with miking designed to add spacious bounce to the single-channel signal. Acknowledging stereo's differing requirements, RCA has decided to re-record the score with the same orchestra and conductor. This time the action-packed music has the aural canvas it deserves and the war at sea takes on a living-room dimension and drama it never had before. This new version is also available in monophonic form.

The 'Cello Galaxy
VILLA-LOBOS: *Bachianas Brasileiras No. 1 and No. 5*
BACH/VILLA-LOBOS: *Prelude and Fugue No. 8*
Felix Slatkin conducting Concert Arts Cello Ensemble
Capitol Stereo Record SP 8484

For this recording session, Capitol imported the EMI stereo technique used by its parent firm in England. A few Capitol and all the Angel releases recorded in Europe employ this method which calls for placement of two mikes in vertical tandem opposite the center point of the orchestra. An angle of 90° is formed at the hub of the two pickup patterns when the mikes are aimed to cover the entire orchestra. In this release, the technique is used at much closer quarters than in any record I've encountered so far. This scales down the cello orchestra to the size of the average living room. In one of the

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Bachianas Brasileiras, music influenced by the style of Bach, the soprano voice of Marni Nixon is recorded with a third mike placed in the center of the instrumental group. Blending of the voice into both channels via the EMI system at this range produces an unsual effect. I noticed that listening at a distance of up to 6 feet from the speakers, the voice appeared with equal intensity in both channels. Reversal of the phasing switch did not change matters, an indication that all was well. Only at normal listening distance did the voice coalesce into a semblance of normal centering. Groove surfaces rival those of the quietest stereo discs being made today, lending further value to a record that should maintain interest long after the musical warhorses have developed a limp.

SCHUMANN: *Cello Concerto in A Minor*
SAINT-SAENS: *Cello Concerto in A Minor*
Janos Starker, cello
Carlo Maria Giulini conducting Philharmonic Orchestra
Angel Stereo Record S-35598

This is a stereo reissue of the only LP in the current catalog that offers a coupling of these well-known concertos for cello and orchestra. The cool brilliance of the Starker performance (he uses a Stradivarius cello) is heard to good advantage now that Angel is pressing a stereo disc with excellent signal-to-noise ratio. The illusion of depth, so vital in a two-channel concerto recording, is very well managed.

The Orchestra
Leopold Stokowski conducting Symphony Orchestra
Capitol Stereo Record SSAL-8385

The mono version of this album was one of the more interesting releases of 1957 because it offered a new insight into the workings of a symphony orchestra. In stereo, the brass, string, woodwind and percussion sections are once again heard individually and in various combinations with the full orchestral climax reached in the final section of Moussorgsky's *Pictures at an Exhibition*. Holding their fire until the present stereo cutters were installed, Capitol's engineers are now in a position to claim one of the top demonstration discs. Ideal stereo, smooth response and up-to-the-minute range make this record a logical candidate for A–B tests conducted with the forthcoming four-track stereo tapes.

MOZART: *Eine Kleine Nachtmusik*
Symphony No. 36 in C Major (Linz)
Antal Dorati conducting London Symphony Orchestra
Mercury Stereo Record SR 90121

This is the way to record music of transparent tonal texture. This latest Mercury stereo disc caught my attention because the transparency is maintained beyond 10,000 cycles. If you're interested in checking the results possible in stereo today when a recording curve is free of peaks in the upper middles, compare this version of the *Nachtmusik* with the recent London CS-6066 stereo disc reviewed in July. On a system that is itself peak-free up to 12,000 cycles (not an impossibility these days), this record walks away with the honors, and there is no slouch in the Dorati performance as it does so.

Popular Overtures
Arthur Winograd conducting Virtuoso Symphony of London
Audio Fidelity Stereo Record FCS 50,011

The stereo records in the Audio Fidelity classical series appear to rely on multiple miking at close range for maximum presence. This technique can be very effective during the quieter passages of the music's dynamic range. Familiar overtures by Thomas, Weber, Smetana, Glinka and Rossini illustrate this point very effectively. Try this record at lower-than-average level in a listening room devoid of distracting background noise. When the music swells in volume, you may notice that a price has to be paid for the exceptional presence noted earlier. The interaction of a large group of microphones scattered throughout the orchestra can create a form of acoustical disturbance that is decidedly unpleasant. It is hard to suppress the feeling that the excellent surfaces and fine audio quality of this series might shine to better advantage with fewer mikes over the orchestra.

More Drums on Fire
World Pacific Stereo Record 1022

The first drum anthology issued by this firm (*Drums on Fire*, WP 1247) was reviewed several

months ago in the mono section of this column. The fact that its sequel has appeared in stereo indicates how rapidly the 45/45 disc has been maturing on this label. The first collection, particularly the section devoted to tabla drums from India, offered a remarkable workout for the best of sound systems. Some exciting history is repeated in this release. I don't recall a cleaner-sounding percussion item on stereo disc. The varied subtlety of some of the drum work will be completely revealed only on the most expensive rigs. If you've made recent improvements in your setup, check them with the last two bands of Side 2. There Mel Lewis contributes some detailed brushwork in a presence and range formerly heard only on the best mono records. Sonny Payne of the Basie band takes us down the home stretch with a treatment of *Clap Hands, Here Comes Charlie* that has smoke curling out of both channels.

STRAUSS: *Also Sprach Zarathustra*
Karl Bohm conducting Berlin Philharmonic Orchestra
Decca Stereo Record DL 79999

Of all the Richard Strauss compositions so far available in stereo, this work appears to benefit most from the added spatial realism of the new medium. In mono recordings, much of the rhetoric of this grandiose tone poem failed to make its point despite the weight of the instrumentation. As heard in this outstanding stereo disc, the score enjoys several significant advantages. Bohm and the men of the Berlin Philharmonic are completely at ease in their native tonal language and the German recording technicians, invariably in the vanguard of audio art, have concentrated on a convincing duplication of concert-hall sonics. I hasten to admit that the torrent of lows heard on good mono discs when the organ joins the orchestra early in the score is but a trickle in this stereo pressing but the rest of the disc forcefully explains on good equipment why this record won a 1959 Grand Prix du Disque award in its category.

HAYDN: *Symphony No. 94 (Surprise)*
Symphony No. 99 in E Flat
Josef Krips conducting Vienna Philharmonic Orchestra
London Stereo Record CS-6027

Concern was expressed at the beginning of the stereo era that the symphonies of Haydn and Mozart would be adversely affected by stereo's ability to separate and set apart the key sections of the orchestra. This reasoning held that the orchestral cohesion sought by composers of that day was best served in mono recordings. This record demonstrates that specialized musical values such as these are not harmed by stereo. Avoiding ping-pong effects, London's miking preserves the scale and balance of the orchestra specified by the composer yet brings us the full impact of the witty comments Haydn planted in the string and woodwind sections. As handled by the renowned Vienna Philharmonic under the genial guidance of Josef Krips, these two works should provide an ideal stereo sampling of Haydn for any Thomas still in doubt.

Sound Spectacular
Ray Anthony Orchestra
Capitol Stereo Record ST-1200

One of the thornier problems confronting the early stereo cutters was a master tape weighted with the sound of a brass section such as the one

(*Continued on page 86*)

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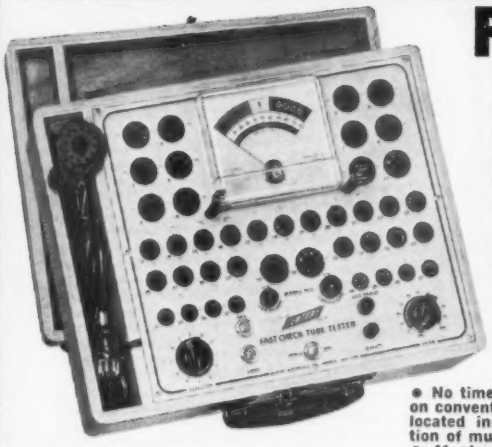

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HUM AND NOISE LEVEL:
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SPEAKER CONNECTIONS: 4, 8, 16, 32 ohms.
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INVERSE FEEDBACK: 25 db
DAMPING FACTOR: 22
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TREBLE TONE CONTROL RANGE: ± 15 db at 10 Kc.
RUMBLE FILTER: 6 db per octave below 50 cps.
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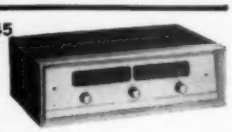

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AUDIO—HIGH FIDELITY

(*Continued from page* 83)

Ray Anthony features in his hard-driving band. His latest disc reveals significant progress in getting such material into the complicated grooves of a stereo record. Distortion is held to the figure found in the average mono disc these days. The sonic vantage point places the listener a few inches from the instruments as tricky arrangements toss folk tunes from one half of the orchestra to the other. The propulsion is furnished by a brass section in each channel with the Anthony trumpet planted in the pivot position.

Gilbert and Sullivan Overtures
Symphony Orchestra conducted by Alan Ward
RCA Victor Stereo Record LSC-2302

It is difficult to find a British orchestra that is not at home in the music of the Gilbert and Sullivan operettas. This anonymous ensemble conveys a high degree of authenticity in these instrumental summations of a half-dozen G and S productions that have found the most favor on our shores. The practised hand of Victor's European affiliate is evident in the exceptionally wide-range frequency response.

Where There's a Man
Abbe Lane; Sid Ramin and His Orchestra
RCA Victor Stereo Record LSP-1899

The initial lineup of stereo discs from RCA Victor contained an album by the same Mrs. Cugat heard in this release. Direct comparison of the year-apart recordings of Abbe Lane's voice spells out the progress made in that time. Levels in both cases are definitely on the high side. The greatest improvement shows up in the tantalizing transients that are a vital part of the sassy night-club tunes featured on this latest record. Spread over an area of 6 to 10 feet, the instrumental background provides occasionally disconcerting moments. The voice miked at dead center has the effect of cutting the orchestra into two halves, each with its own arrangements. The vocal pickup is "in person" all the way.

BRUCH: *Scottish Fantasia*
MENDELSSOHN: *Violin Concerto in E Minor*
Campoli, violin
Sir Adrian Boult conducting London Philharmonic Orchestra
London Stereo Record CS-6047

The *Fantasia* of Max Bruch is a rare composition for violin and orchestra based on Scottish folk tunes. The composer drew extensively on collections of songs gathered in Scotland in the 18th century. This refreshing music achieved its greatest fame during monophonic days in the Heifetz performance on the Victor label. Now stereo opens a new door on the Highland landscape. From a technical standpoint, an interesting feature on the record is the comprehensive frequency response of the bass drum heard at the outset of the first movement. The score calls for a series of occasional soft bass-drum beats at a volume too low to be heard with ease on previous records. While maintaining this volume, London captures the drum's basic frequency. We've known for some time that virtually any component system worthy of the term can give you the overtones of a bass drum if the levels are high enough in recording and playback. Only the best stereo equipment will reproduce the low-level bass frequency recorded here. As for the performance, Campoli fans will welcome his proficiency and tonal warmth both in the *Fantasia* and the Mendelssohn violin concerto.

SCHUMANN: *Symphony No. 1 in B Flat Major*
Paul Paray conducting Detroit Symphony Orchestra
Mercury Stereo Record SR 90198

Schumann's *Spring Symphony* describes an overcast day in this recording. Several factors, not all of them the fault of the recording engineers, create a problem here. The symphonies of Schumann pose difficulties in recording due to the thick texture of the scoring. The acoustics of the Ford Auditorium, the permanent home of the Detroit Orchestra, do not lend themselves to the music as miked here. The stereo sound is tubby enough to require complete rolloff of the bass, a step I haven't taken since the appearance of the stereo disc.

Strings Around the World
Peter Plum conducting Brussels World's Fair Orchestra
Omega Stereo Record OSL-23

A cosmopolitan treatment of moody items best handled by strings. *Charmaine, Laura, Green-*

sleeves, etc., are heard in very clean depth. This is an interesting memento of the Brussels Fair in sound far better than that found on some of the major labels.

Note: Records below are 12-inch mono LP and play back with RIAA curve unless otherwise indicated.

Bulgaria
Columbia World Library of Folk and Primitive Music
Columbia KL-5378

Columbia Records, in this monumental series compiled and edited by Alan Lomax, continues to probe the bed rock beneath the world's folk music. On this record, the seventeenth in the series, students of folklore will find higher-than-average technical skill in field recordings made in the villages of Bulgaria. The songs and dances reflect at least five cultures of European and Asiatic origin preserved in a country that, until recent years, had little contact with the outside world. It is interesting to note that the instrumental playing is confined to the men because women who play instruments are not considered suitable for marriage.

Top and Bottom Brass
Clark Terry Quintet
Riverside RLP 12-295

They cover just about all the bases in this one. At one extreme is the tuba of Don Butterfield, at the other is Clark Terry's irrepressible trumpet which paces the proceedings with unfailing good humor. In some of the selections Terry, an Ellington and Basie sideman, takes on a fluegelhorn, a slightly larger version of the trumpet with a mellower sound. In the longest item on the disc, *Blues for Etta*, Clark Terry breaks out of bounds with an amazing solo on trumpet mouthpiece. This sums up the carefree attitude sprinkled throughout the disc. This project will be relished by those who feel that jazz has been taking itself a bit too seriously in some quarters. END

Name and address of any manufacturer of records mentioned in this column may be obtained by writing Records, RADIO-ELECTRONICS, *154 West 14th St., New York 11, N. Y.*

CORRECTION

Mr. Queen points out that the value of the calibrated potentiometer (R1) is incorrect in his article "Check Transistor Gain" on page 70 of the July issue. R1 should be 10 instead of 100 ohms. With R1 as 10 ohms, the total resistance of R1 and R2 is 100 ohms. From the alpha equation

$$\frac{R2 + R1\text{-}a}{R2 + R1} = \frac{R2 + R1\text{-}a}{100}$$

it is obvious that R2 + R1-a will give alpha directly (as a percentage). R1-a is calibrated by the 0–10 dial. For example; when the dial reads 6.5, R1-a is 6.5 ohms, R2 + R1-a is 96.5 ohms and alpha is 0.965. In the same way, a dial reading of 4.8 corresponds to an alpha of 0.948 and so on.

THE BIG NEWS FOR 1960

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- **The 23-inch* tube flattens the TV screen. "Bonded shield" face-panel eliminates the dust trap, cuts reflections in half, and improves brightness and contrast.**
- **New Super HaloLight® is bigger and better than ever. It's a Sylvania exclusive that adds eye comfort to eye appeal.**

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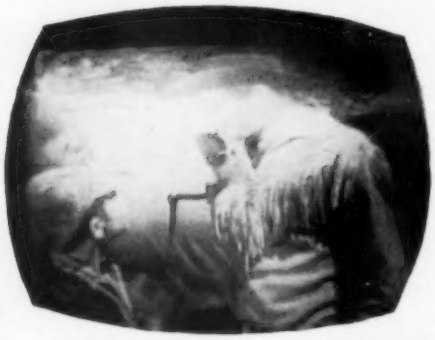
DIAGNOSE COMMON TV FAULTS

A picture of a TV screen and a discussion of the picture can help the technician fix a TV set. But his knowledge of circuit theory is still needed if he is to do a rapid but accurate job

By A. V. J. MARTIN



1

Symptoms: A blank part of the screen is visible above the picture. The lowest part of the picture is lost below the bottom of the screen. Do not mistake this defect for the one in problem 8.

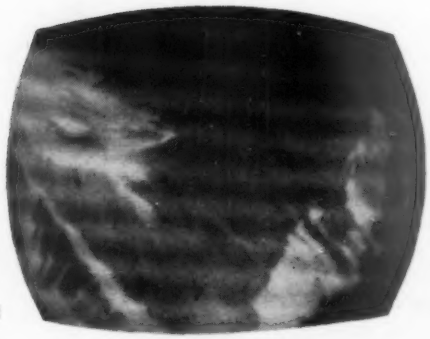
Diagnosis: **Poor centering.** The defect can occur horizontally or vertically. Readjust centering controls and align focus assembly. Switch connections to the focus coil. If components have been replaced or moved, watch for magnetic fields of speakers or filter coils.

3

Symptoms: Irregular luminosity. Brightness decreases from left to right.

Diagnosis: **1. Parasitic modulation at the horizontal sweep frequency.** Switch to an empty channel or disconnect the antenna. This makes the fault easy to see. Use a scope at the horizontal sweep frequency to check for the point where the parasitic modulation appears—generally the cathode or grid of the picture tube. Alternately, short picture-tube pins to ground through a 0.1 μf capacitor. Once the point of entry is identified, check the circuit components. The usual culprit is an open decoupling capacitor.

2. Induction at the horizontal sweep frequency. Check lead dress, particularly for leads going to the picture-tube socket or deflection coils. Make sure that shields are properly fastened and grounded, especially in the high-voltage, detector and video parts of the TV receiver.



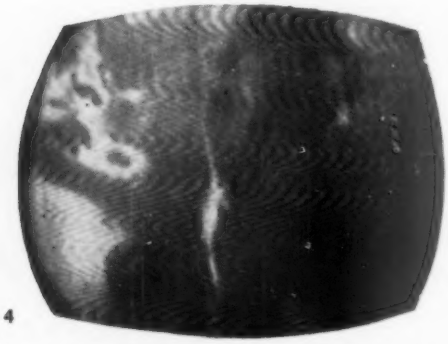
2

Symptoms: Gray or black horizontal bars across the picture, following the rhythm of the audio sound.

Diagnosis: **Sound bars.** If the defect is independent of the audio volume: Adjust oscillator tuning. Check video if alignment. Look for out-of-tune sound trap. Also for instability or oscillation in the picture if section. Check the decoupling capacitors and the ground points.

If the defect increases with the sound volume, the audio output stage may be bad. Check tube, bias and grid coupling capacitor. Also look over the audio decoupling circuit and check for a bad B-plus filter.

Microphonic tube can also be cause. Easily identified by hitting gently with eraser on a pencil. If components have been replaced or displaced, there can be direct induction from the audio output transformer.



4

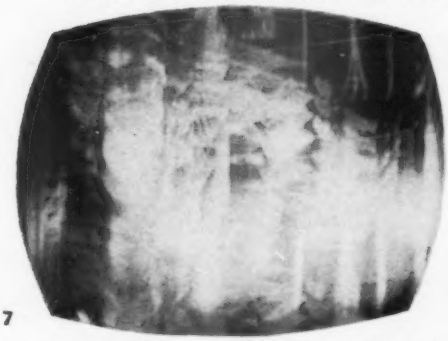
Symptoms: Unstable wavy lines superimposed over the picture.

Diagnosis: **Herringbone pattern, due to interference.** The trouble can be internal or external. Oscillation in the video or sound if may be the cause. Check screens, decoupling circuits, chokes, lead dress. If due to an interfering transmitter, reorient the antenna, install a trap in the antenna input or use a shielded antenna lead-in (coax cable).

5

Symptoms: Excessive brightness.

Diagnosis: **Pix tube or video circuits.** If brightness control is more or less effective, readjust brightness control. Check for proper dc restoration. If defective, brightness varies irregularly. Check the clamping diode circuit; incorrect voltage on cathode or grid of the pix tube. If dc coupling is used between the video stage and the pix tube, an incorrect voltage may be caused by the video amplifier. Check tube and bias.
If the brightness control is practically ineffective, the control may be defective. Check picture-tube cathode and grid circuits. Look for a cathode-to-grid short.



7

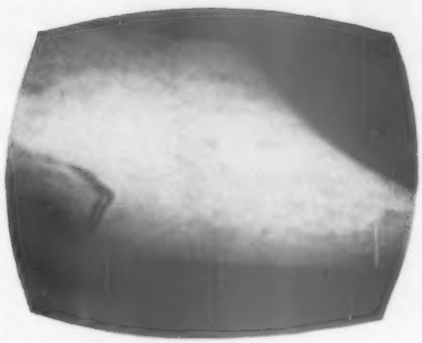
Symptoms: Several pictures superimposed vertically, either stable or moving up or down.

Diagnosis: **1. Vertical sync defective.** Adjust vertical hold control. Replace vertical oscillator. Check circuit. Check sync circuits. Use a scope at frame frequency to follow sync signal from plate of sync separator.
2. Intense ghosts. Orient antenna or install more directive unit.
3. High-voltage arcing. Find and stop.

9

Symptoms: Light, moving streaks over all or part of the picture. Sometimes, the pattern can be identified as a part of the picture, drawn out horizontally.

Diagnosis: **Part of picture modulation occurs during horizontal retrace.** Readjust horizontal hold. Check for excessive retrace time. This can have a number of causes—defective horizontal yoke coils or horizontal output transformer, horizontal ouput tube or damper, horizontal oscillator or output transformer. Another possiblility is a defect in the afc circuit, generally in the phase comparator. Change tube. Check components.



6

Symptoms: Excessive contrast.

Diagnosis: **1. Too much video voltage.** Adjust contrast control. Some sets have a preset control or a switch.
2. Excessive field intensity. Insert an attenuator in the aerial lead-in.
3. Defective agc.
4. Video receiver misaligned. Delivers excessive low-frequency response. Realign.

8

Symptoms: Black zones in the corners or on the edges of the screen.

Diagnosis: **1. Misadjusted ion trap.** Generally there is a loss of brightness as well.
2. Deflection coils do not fit snugly against the neck of the picture tube. Adjust yoke.

10

Symptoms: Irregular streaks across the picture.

Diagnosis: **Static or man-made interference.** Disconnect the antenna. If the static disappears, connect another antenna or a length of wire. If no static now, check the antenna and lead-in installation. If static is still there, try to reorient the antenna or increase its height. Use a shielded lead-in. Using a direction-sensitive portable radio, try to locate the offending equipment. If static originates in the receiver, it may be sensitive to jarring the cabinet. Turn off the lights and have a good look to locate high-voltage arcing or corona. Also look for a defective tube. Use the rubber-hammer method. A poor contact can also be the fault. This can be a dilly. Check stage by stage. Look for poor insulation or arcing anywhere, but generally in the high-voltage section.
The next part of this series will be published in an early issue. END

Winegard's

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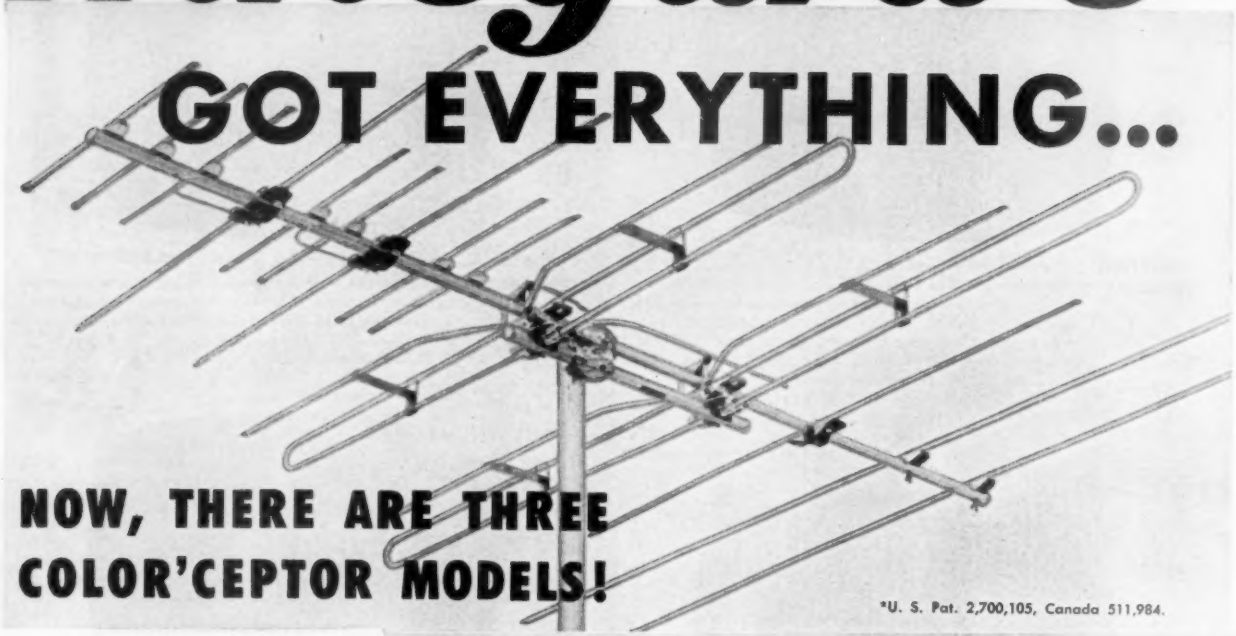

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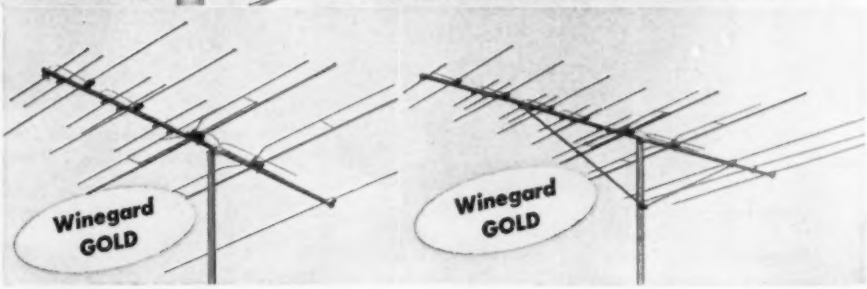

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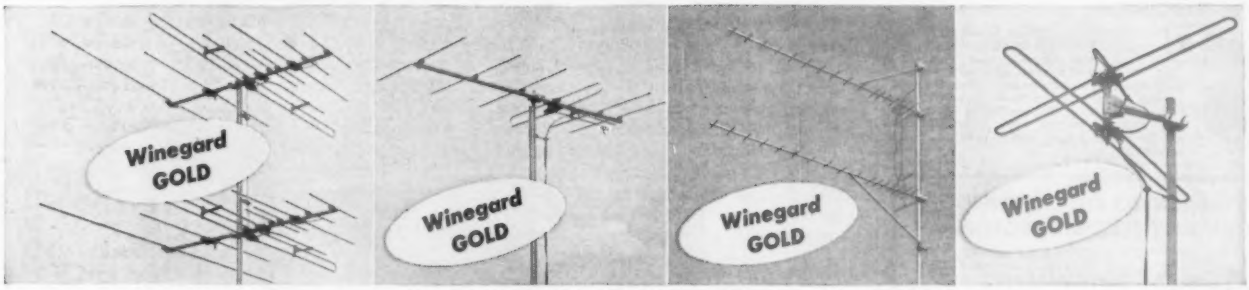

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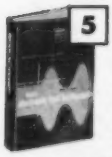

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MORE requests concerning arcing in the neck of the picture tube are coming in. Most of the time, this arcing includes the yoke, which is often damaged and must be replaced. After a while—anywhere from a week to a couple of months—the arcing starts again.

This sneaky type of trouble often does not show up even on a wide-band scope, because the frequency of the arc voltage is too high to be displayed on the scope screen.

The trouble is caused by spurious oscillation in the yoke system. This oscillation not only increases the peak-to-peak voltage applied to the yoke windings, but also ionizes the air about the yoke, which aggravates the arcing.

The spurious oscillation must be suppressed. A good point at which to attack this is at the damper tube.

A typical circuit which sometimes requires such suppression is shown in Fig. 1. Adequate suppression is usually obtained by connecting a 150-$\mu\mu$f capacitor from plate to cathode of the damper.

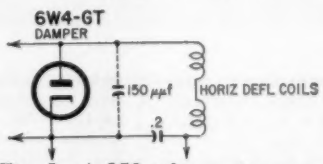

Fig. 1—A 150-$\mu\mu$f capacitor connected between damper plate and cathode often stops yoke arcing.

The capacitor must have an adequate voltage rating. This requirement varies widely. In some receivers, a 600-volt capacitor will do. But I have seen receivers in which the peak-to-peak stress was as high as 3 kv. Check the circuit, or consult the service data for the receiver.

When a high-voltage capacitor is not readily available, lower-voltage capacitors can be hooked in series as in Fig. 2. If considerable dc voltage must be withstood, as well as ac, it is highly advisable to bleed each capacitor with a 5-megohm resistor (shown in dashed lines in Fig. 2). This equalizes the dc voltage distribution, which is otherwise upset by different insulation resistances in the series capacitors.

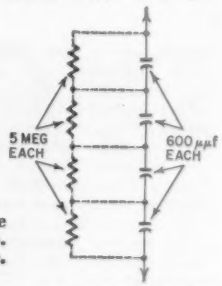

Fig. 2—A high-voltage 150-$\mu\mu$f capacitor can be made by connecting four 600-$\mu\mu$f units in series. Shunt each capacitor with a 5-megohm resistor.

Series inductance can be used instead of shunt capacitance, as shown in Fig. 3-a. In stubborn cases, inductive choking is often most effective. Ordinary heater chokes do a good job.

When current drawn by the circuit is not heavy, small damping resistors can be used instead of chokes, as shown in Fig. 3-b. Any suppressor should be connected directly at the socket terminals. Otherwise, lead resonance will sustain the spurious oscillation.

Sometimes, suppression must be carried as far as the horizontal output tube. The same means are used—suppressor chokes or damping resistors.

Antenna installation

I have run into an antenna installation problem in a relatively dead spot

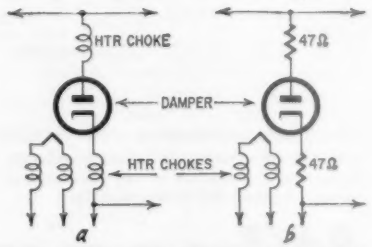

Fig. 3—Suppressing spurious oscillation: a—Use small inductances, such as heater chokes in plate and cathode leads: b—Small resistors, 47 ohms, can be used instead of chokes in circuits which do not draw heavy current.

CBS TELEVISION SHOWS TOP-RATED BY RATING SERVICES

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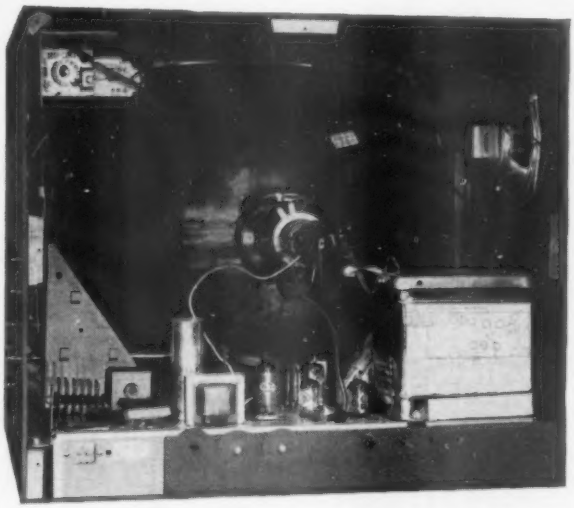

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TELEVISION

for out-of-town signals. Channels 3 (Jackson, Miss.), 4 (Columbus, Miss.), 5 (Mobile, Ala.), 4 and 6 (New Orleans, La.), and 9 (Hattiesburg, Miss.), can be received most of the time, but are much too snowy. Channel 3 is good outside of this difficult area. I installed two types of all-band high-gain antennas, one of them on a 40-foot mast. I tried a booster, but it only amplifies the snow. This is not receiver trouble, as reception is about the same on four sets. Sound comes through OK.—J. P., Meridian, Miss.

Ten-element Yagis cut to channel will give the best signal-to-noise ratio and the strongest signals. Stacking additional Yagis provides further advantage. This solution requires a separate installation for each channel and runs into money. A separate lead-in should be run from each installation. Harnesses or couplers will result in some insertion loss. Instead of stacking, try a booster at the antenna. A booster at the receiver end gets lead-in noise fed into its input. Triode type boosters using the cascode circuit give the best signal-to-noise amplification. Multi-element Yagis are very directional and must be oriented horizontally and vertically to coincide with the prevailing signal vector.

Improve high-frequency response

I want to improve the high-frequency response of a Mirrortone C250953 by

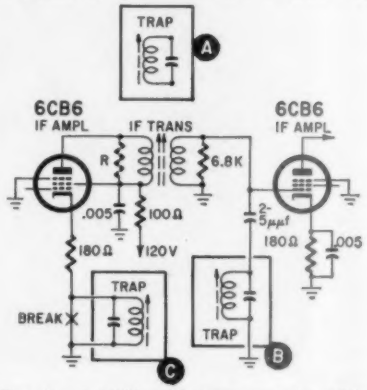

Fig. 4—A bifilar if stage can be wide-banded by adding resistor R. To add a trap, use A or B. C is shown, but can be tricky.

increasing the bandwidth of staggered if stages, using damping resistors. This is a strong-signal area, where gain can be traded for bandwidth. With greater bandwidth, I expect that a 21.6-mc trap will also be required. This is the picture-carrier frequency.—C. S. T., Vancouver, Wash.

This is a practical approach to better picture definition. You can use a resistor across the bifilar primaries (see Fig. 4), or you can reduce the value of the 6,800-ohm secondary resistor. Suitable values of damping resistors can be found only by experiment, and the result must be checked with a sweep

(*Continued on page* 98)

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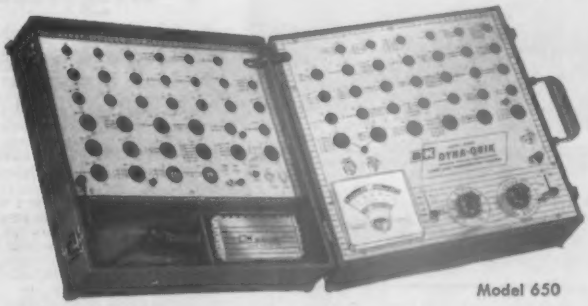
Today's Finest Portable Tube and Transistor Tester

Accurately checks over 99% of the tubes most widely used in television receivers, plus popular home and portable radio tubes. Tests over 600 tube types. Lists over 125 most popular tube types, with settings, on socket panels for maximum operating speed. Complete listing in fast, index-type selector. **Measures true dynamic mutual conductance.** Tests each section of multiple tubes separately for GM, Shorts, Grid Emission, Gas Content and Life. Includes 16 spare sockets and ample filament voltages for future new tube types. **Transistor Section** checks transistors, diodes, and selenium rectifiers. Luggage-type carrying case. Net, $169.95



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Superior's New Model TW-11

STANDARD PROFESSIONAL TUBE TESTER

★ Tests all tubes, including 4, 5, 6, 7, Octal, Lock-in, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Sub-minars, Proximity fuse types, etc.

★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TW-11 as any of the pins may be placed in the neutral position when necessary.

★ The Model TW-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.

★ Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.

★ NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

Model TW-11—TUBE TESTER . . . Total Price $47.50—Terms: $11.50 after 10 day trial, then $6.00 per month for 6 months if satisfactory. Otherwise return, no explanation necessary!

EXTRAORDINARY FEATURE—SEPARATE SCALE FOR LOW-CURRENT TUBES. Previously, on emission-type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

The Model TW-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover.

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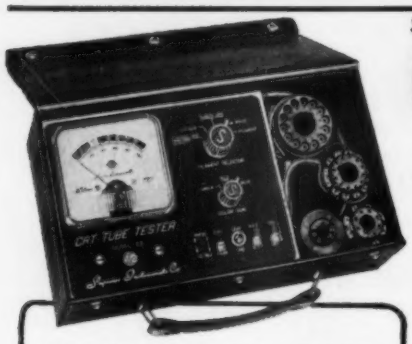
SUPERIOR'S NEW MODEL 83

C.R.T. TESTER

TESTS AND REJUVENATES ALL PICTURE TUBES



Model 83—C. R. Tube Tester. Total Price $38.50 Terms $8.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

ALL BLACK AND WHITE TUBES

From 90 degree to 110 degree types—from 8" to 30" types

- Model 83 is not simply a rehashed black and white C.R.T. Tester with a color adapter added. Model 83 employs a new improved circuit designed specifically to test the older type black and white tubes, the newer type black and white tubes and all color picture tubes.
- Model 83 provides separate filament operating voltages for the older 6.3 types and the newer 8.4 types.
- Model 83 employs a 4" air-damped meter with quality and calibrated scales.
- Model 83 properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.

ALL COLOR TUBES

Test ALL picture tubes—in the carton—out of the carton in the set!

- Model 83 will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus. To test for such malfunction, you simply press the rej. switch of Model 83. If the tube is weakening, the meter reading will indicate the condition.
- Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83 applies a selective low voltage uniformly to assure increased life with no danger of cathode damage.

Model 83 comes housed in handsome portable Saddle Stitched Texon case—complete with sockets for all black and white tubes and all color tubes. Only—

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GENOMETER

7 Signal Generators in One!

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- ✔ Audio Frequency Generator
- ✔ Bar Generator
- ✔ Cross Hatch Generator
- ✔ Color Dot Pattern Generator
- ✔ Marker Generator

Model TV-50A—Genometer. Total Price—$47.50. Terms: $11.50 after 10 day trial, then $6.00 monthly for 6 months if satisfactory. Otherwise return, no explanation necessary.

A versatile all-inclusive GENERATOR which provides ALL the outputs for servicing:

A.M. Radio • F.M. Radio • Amplifiers • Black and White TV • Color TV

R. F. SIGNAL GENERATOR: The Model TV-50A Genometer provides complete coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

VARIABLE AUDIO FREQUENCY GENERATOR: In addition to a fixed 400 cycle sine-wave audio, the Model TV-50A Genometer provides a variable 300 cycle to 20,000 cycle peak wave audio signal.

BAR GENERATOR: The Model TV-50A projects an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars.

CROSS HATCH GENERATOR: The Model TV-50A Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting, horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

DOT PATTERN GENERATOR (FOR COLOR TV) Although you will be able to use most of your regular standard equipment for servicing Color TV, the one addition which is a "must" is a Dot Pattern Generator. The Dot Pattern projected on any color TV Receiver tube by the Model TV-50A will enable you to adjust for proper color convergence.

MARKER GENERATOR: The Model TV-50A includes all the most frequently needed marker points. The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc. (3579 Kc. is the color burst frequency).

THE MODEL TV-50A comes absolutely complete with shielded leads and operating instructions.

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USE APPROVAL FORM ON NEXT PAGE

Superior's New MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL-VIEW METER

Compare it to *any* peak-to-peak V. T. V. M. made by *any* other manufacturer at *any* price!

- **Model 77 completely wired and calibrated with *all* accessories (including even portable carrying case) sells for only $42.50.**
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- **Model 77 uses new improved SICO printed circuitry.**
- **Model 77 employs a 12AU7 as D.C. amplifier and two 9006's as peak-to-peak voltage rectifiers to assure maximum stability.**
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- **Model 77 meter is virtually burn-out proof. The sensitive 400 microampere meter is isolated from the measuring circuit by a balanced push-pull amplifier.**
- **Model 77 uses selected 1% zero temperature coefficient resistors as multipliers. This assures unchanging accurate readings on all ranges.**
- **AS A DC VOLTMETER:** The Model 77 will measure any voltage up to 1500 volts with negligible loading. It is indispensable in receiver and Hi-Fi Amplifier servicing and a must for Black and White and Color TV Receiver servicing where circuit loading cannot be tolerated. A special feature permits accurate zero center measurements necessary for the true alignment of Foster-Seely (Armstrong) FM detectors, Ratio Detectors and the newer Gated Beam Detectors.
- **AS AN AC VOLTMETER:** The old-fashioned laboratory AC V.T.V.M. was cumbersome, erratic and required several dial manipulations to arrive at a reading. The Model 77 when connected to a circuit will quickly and simply measure its RMS value if sine wave, and its peak-to-peak value if complex wave. Pedestal voltages that determine the "black" level in TV receivers, sync. pulses and saw tooth voltages are easily read with the Model 77.
- **AS AN ELECTRONIC OHMMETER:** Because of its wide range of measurement in the resistance range (from .2 ohms to 1,000 megohms) the Model 77 will be your most frequently used resistance meter. Leaky capacitors which may not show up on other resistance meters, show up glaringly when tested with the new Model 77. Because of its sensitivity and low loading, intermittents are more easily found, isolated and repaired.

Model 77—Vacuum Tube Voltmeter, Total Price $42.50. Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

Traditionally, the V. T. V. M. has been the one instrument used for voltage measurements where low-drain or wide frequency resoanse is essential. And now, the Model 77 V. T. V. M. by taking advantage of new developments including modern balanced push-pull circuit design, etched circuitry, an extra large meter and other improvements provides such measurements quicker, with a higher degree of accuracy and with better readability.

The Model 77 will measure DC with negligible loading AC of ANY FORM WAVE; whether sine wave, pulse wave, spike wave, square wave or other complex wave forms. It will measure all AC from 30 cycles to over 5 megacycles and will do so without additional accessories or cables.

SPECIFICATIONS

- DC VOLTS—0 to 3/15/75/150/300/750/1500 volts at 11 megohms input resistance
- AC VOLTS (RMS)—0 to 3/15/75/150/300/750/1500 volts.
- AC VOLTS (Peak to Peak)—0 to 8/40/200/400/800/2000 volts.
- ELECTRONIC OHMMETER—0 to 1000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms.
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Model 77 comes complete with operating instructions, probe and test leads. Use it on the bench—use it on calls. A streamlined carrying case, included at no extra charge, accommodates the tester, instruction book, probe and leads. Operates on 110-120 volt 60 cycle. Only.....

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For reliability assurance, insist on Pyramid "Gold Standard" capacitors from your distributor. Catalog available.

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TELEVISION

(*Continued from page* 94)

generator and scope to avoid needless waste of time and effort. A trap or two will probably be desirable, after the if amplifier is wide-banded. However, the trap(s) must not be tuned to reject the co-channel carrier. We seek to reject adjacent-channel carriers, and to attenuate the co-channel sound to suitable levels. Of the types A, B, and C traps shown in Fig. 4, I have found A the most straightforward to install, with B running a close second. C is tricky, and sometimes leads to instability because of in-phase feedback within the stage. Experiment with different degrees of coupling, with trap A, to get the best bandwidth and desired rejection as shown by sweep tests. Finally, it must be strongly emphasized that increased if bandwidth will be of no avail unless the video amplifier is also wide-banded. This is determined by the video amplifier plate-load impedance. The video amplifier can be swept and marked for checking bandwidth. Correct response is determined both by values of plate-load resistance and peaking-coil inductance (see Fig. 5). Finally, most rf tuners have wide-band response, though some do not. This should also be checked with a sweep generator and scope.

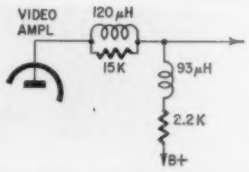

Fig. 5—To get full video amplifier response, use a suitable R-L plate-load combination. The circuit shown gives full 4-mc response if stray capacitances are not excessive.

Video sharpening circuit

I would like to add a video sharpening circuit to a receiver using a picture-tube input circuit with ac coupling. —K. V., Ontario, Canada

The video can be sharpened by shunting a small capacitor across the contrast control, as in Fig. 6. Start with 470 μμf and vary the capacitance for best sharpening. Picture crispening can be carried only to a point at which circuit ghosts or "repeats" become noticeable in the image. To understand the nature of video sharpening, refer to Fig. 7. These video amplifier response curves show how the small capacitor causes

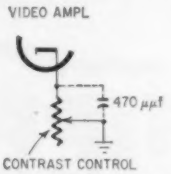

Fig. 6—The simplest video sharpening circuit consists of partially bypassing the contrast control.

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REPLACEMENT
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Negligible in amplifiers requiring an input voltage of at least 50 mv for an output of 5 watts.

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Better than — 60 db relative to 50 mv when the grid circuit impedance is no greater than 0.5 megohms (at 60 cps), the center tap of the heater is grounded and the cathode resistor is by-passed by a capacitor of at least 100 mfd.

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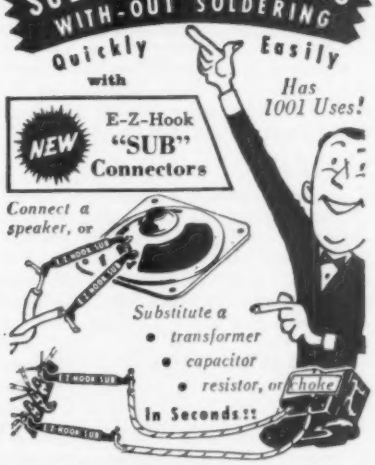

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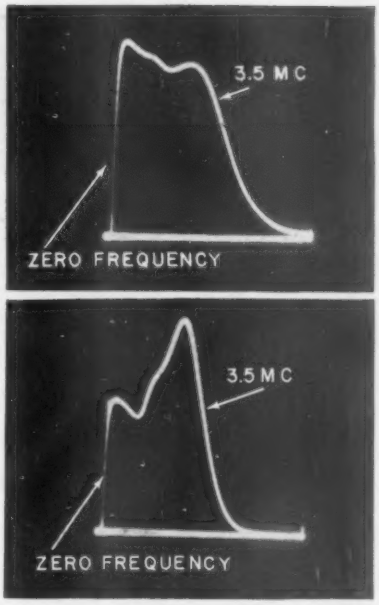

Fig. 7—(top) Video amplifier response curve without partial bypassing of cathode. (bottom) High video peaking obtained with partial bypassing.

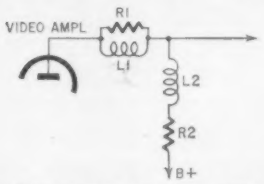

Fig. 8—Parameters in plate configuration also control video sharpening action. L2's value (shunt peaking coil) is important factor.

high video peaking. In some receivers using large peaking coils, it is also helpful to adjust inductance values to get the best sharpening effect (Fig. 8). This job is facilitated by using a good video sweep generator and oscilloscope.

Swishing background noise

Can you give some advice on an obstinate Sparton 5281 with a swishing background noise in the sound? The swishing follows amplitude variations in the sound. Picture quality is good, but audio is weak on the weaker channels. A check with my scope shows normal if and sound alignment.—N. J., Antioch, Calif.

Despite the scope's showing a normal response for the sound section, I suspect regeneration and instability due to Miller effect. This leads to a "walking" sound if response. To check, display the complete sound-strip response from the sound takeoff point to the FM detector output. Then, raise and lower the sweep output level from the generator. You will probably see the response pattern moving horizontally or "walking" the scope base line. To correct, check screen bypass capacitors, grounding of tube shields and similar conditions that can cause feedback. END

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SONIC CUSTOM-CRAFT S-100 low-priced hi-fi 10 watt stereo, master control center, and dual amplifiers. 5 watts per channel develops 20 watts of peak power. 50 to 15,000 cps response with less than 5% of total harmonic distortion at full rated power. Hum and noise, 45 db below maximum rated power. 4 stereo or monophonic inputs. 8 ohm outputs for single or double operation.
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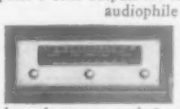

SONIC CUSTOM-CRAFT MODEL 19 FM-AM TUNER Super-sensitive tuner features drift-free automatic frequency control performance and 3-gang tuning capacitor for optimum selectivity. Sensitivity-FM 5 μv for 30 db quieting. Total harmonic distortion at rated output, less than 1.5%. Selectivity bandwidth at 6 db point: FM 200 kc, AM 9 kc. Frequency response, FM ± 2 db of standard de-emphasis curve, AM 20 to 9,000 cps. Function switch AM, FM or FM-AFC.
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SONIC CUSTOM-CRAFT S-400 (pictured above) Quality combination 40 watt stereo amplifier, master control center, and transistorized preamplifier. 20 watts per channel delivers 80 watts of peak power. Frequency response, flat from 20 to 20,000 cps ± 0.5 db. Less than 1% total harmonic distortion at full rated output. Built-in stereo test signal to adjust channel and speaker balance as well as speaker phasing. Sonic Stereo Monitor, a precision meter shows when both channels are properly balanced. 8 inputs and 9 front panel controls handle any program source. 4, 8 and 16 ohm outputs for single, double or triple channel operation. audiophile net with enclosure **$99.95**

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4, 8 AND 16 OHM IMPEDANCES
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NEW! LORENZ S-1288

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fm tv dx

By ROBERT B. COOPER, Jr.

THE late April and September–October periods have great similarities in the Midwest, South and Atlantic Coast areas. Thus a quick survey of what happened during late April and early May can provide some insight into what dxers in these areas can expect in coming weeks.

Bill Eckberg, Walnut, Ill., found the high- and low-band channels open into the southwest on extended ground wave the evening of May 11. Stations in Oklahoma (KOCO-5, KWTV-9); Missouri (KODE-TV-12) and Mississippi (WJTV-12) joined others much closer for a good extended-ground-wave (trops) session.

In the Southeast, Franklin Brown, Easley, S. C., found ground wave good to the west and north on the mornings of April 27–28. And Donald Ruland, Holly Hill, Fla., found the same mornings good . . . and the evening of the 27th hot. In fact, he found stations "ten deep" on some channels and interference too rough for decent identification of the dx stations. And this on ground wave!

Farther west, the same conditions which moved into the southeast on April 27–28 brought 800-mile ground wave to Jim Hines, Joes, Colo., the morning of April 26. Hines found signals of Texas, Louisiana and Oklahoma stations all over the dial from 830-1030 am CST, including KSLA-TV-12, 800 miles; KTRK-TV-13, 810 miles, and KWTX-TV-10, 710 miles. Note that this weather pattern, which brought extended ground wave to the Midwest on the 26th, moved into the Southeast on the 27–28th, repeating the performance there. In both cases, early-morning dx was best.

June 17, 1959

Reports are incomplete as yet but, by all standards, the evening hours of June 17, from 3 to 8 pm CST should have seen the biggest FM E-skip opening to hit the East and Midwest in nearly 4 years. Signals from the Panhandle of Texas were skipping into western New York on frequencies as high as 152 mc, as indicated by interference experienced by the Buffalo, N. Y., Police Department from the Amarillo, Tex., police radio. There is a chance that TV dxers in these regions may have had the chance to log channel-7 skip signals over the same path. Reports will tell.

METEOR SHOWERS (Aug. 20–Oct. 23)

Name	Date	Time (LST) Max. Burst Rate	Direction*	Grade
Draconids	Aug. 21–31	1300–1630	NW–SE	B
		1630–2130	E–W	B
		2130–0100	SW–NE	B
Perseids	Sept. 7–15	0030–0200	NW–SE	B
		0700–0830	SW–NE	B
Aurigids	Sept. 22	0030–0200	NW–SE	C
		0800–0830	SW–NE	C
Quadrantids	Oct. 2	0900–1400	NW–SE	C
		1400–1500	E–W	C
		1500–2000	SW–NE	B
Giacobinids	Oct. 9	1100–1600	NW–SE	AAA
		1600–1700	E–W	AAA
		1700–2200	SW–NE	AAA
Arietids	Oct. 12–23	2130–2330	N–S	B
		0230–0430	N–S	
Orionids	Oct. 18–23	0000–0200	N–S	A
		0600–0800	N–S	A
		0430–0600	NW–SE	A
		0330–0430	E–W	A
		0200–0330	SW–NE	A

*Direction pertains to path along earth's surface between observer and station. Certain hours give best results in certain directions.

Predictions

Meteor Showers: The table of meteor showers listed explains the showers expected during the months of September and October. Oct. 9 should be circled on your calendar as the most amazing and unusual dx date since 1946, and the most unusual day you will be likely to see until 1972! This date—from 11 am until 10 pm local standard time—will be the date of a most intense and unusual meteor shower. Meteor counts as high as 400

"Do you give green stamps?"

per minute make skip on channels 2–6, the FM band, *and channels 7–13* almost a certainty during the 11-hour period.

The most unusual thing about the whole affair—the skip signals on all vhf channels and the FM band—will be coming in from *all directions* during the entire period. Signals will have the general appearance of a sporadic-E opening with fast fading . . . except that it can be expected on all channels—even to channel 13! We cannot emphasize the importance of this opening greatly enough. If you are an experienced dxer and have a good log of low-band E-skip stations, we recommend you watch the high band (7–13) for a chance to fill out your log in this area. FM dxers will do well to run a tape recorder during the entire proceedings. Due to the general coverage of the opening, interference will be fantastic on all quarters. Be sure to mark *Oct. 9* on your calendar as a red-letter day for dx.

E Skip: The last waning weeks of the E-skip season should be upon you as you read this, in late August. Generally speaking, E skip gets weaker and weaker after Aug. 15, and the last openings—though they may hang on as late as Sept. 15—generally occur for shorter and shorter periods of time and are confined to areas along the Canadian border, Great Lakes, and Gulf Coast. These openings generally affect only channels 2 and 3, and occur on east–west paths (such as Miami to Houston) as opposed to north–south paths (such as Minneapolis to Houston). A general rule of thumb, watch to your east in the morning hours, and to the west in late afternoon hours.

Trops: For Midwestern, Southern and Atlantic Coast area dxers this is the season. Hurricane weather patterns may do little for your local football game, but they do bring dx conditions in the South and along the Atlantic Coast. And in the Midwest, a cooling spell in late August or early September followed by Indian Summer is a sure sign that ground wave is about to improve. In either case, watch your fringe-area stations for signs—and then look for stations farther away. Pay particular attention to the high-band vhf and uhf channels, in the Midwest.

Report forms

As we study reports of distant FM and television reception, we continue to find it increasingly valuable that dxers report to this column on our report forms. When you use these forms, tabulation of individual loggings is made a fairly simple job, and we are assured that no logging of yours will go unnoticed. The forms are free to you, and may be had by simply dropping a postcard with the phrase "Dx Forms" and your address to TV–FM Dx Column, RADIO-ELECTRONICS, 154 W. 14th St., New York 11, N. Y. END

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Oscillator Squegging

This form of spurious oscillation can produce some puzzling symptoms

By LUCIAN PALMER

THE old farmyard pumps produced water in spurts as a result of regular up-and-down motion on the handle. Water did not flow between the spurts (on the handle's upstroke).

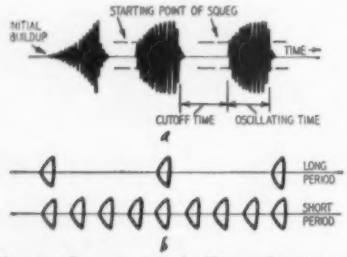

Fig. 1—Squegs are built up in groups or packets that recur regularly; 1-*a*—typical case of build-up; 1-*b*—long and short dead times of the oscillator.

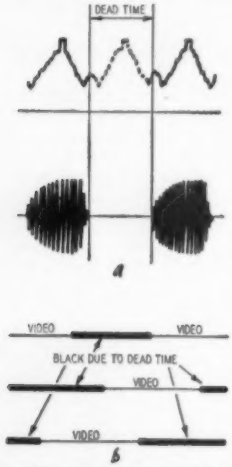

Fig. 2-a—Dead time correlated with video information. The dead time may cover part of a synchronizing period, either horizontal (as shown here) or vertical; b—dead-time symptoms on the picture tube. Successive periods are black. Some may occur during blanking and appear at the finish and start of an active trace.

A squegging oscillator produces a similar output. Fig. 1-a shows squegs (groups or packets of oscillations) with intervening "dead" spaces. There is no oscillation and no output during this dead time. The length of the oscillation period and the dead time are not necessarily equal, but depend on circuit constants, as does the period or repetition frequency of the squegs. This period may be very low, measurable in minutes, or very high and measured in microseconds.

Symptoms of squegging

If the local oscillator of a radio set squegs, it punches holes in the sound as if a mechanical chopper had been inserted in the set. This is because no intermediate frequency is produced when there is no oscillation — during the dead times of Fig. 1-a.

The frequency of the squeg may vary like the quench periods of a superregenerative receiver. The oscillatory packets may close up or spread apart (Fig. 1-b). If the frequency is in the audible range, a radio receiver with a squegging local oscillator will produce sounds varying from a buzz to "plops." A squeg rate above audibility will result in a high hiss level or an increase in noise on a station.

Local-oscillator squegging of a TV front end punches holes in the picture and sound intermediate frequencies. The eye will often see the effects on the picture even though the sound may not seem to be affected.

As an example, if the dead period is 10 microseconds, about one-fifth of a horizontal line will be black — due to absence of video information for that part of the 54 μsec of active scan. (Unless the squeg occurred in the blanking period, but due the repetitive nature of squegs, succeeding dead times will fall on the active portion of the line.)

As dead time increases, some of the dead spots will fall during sync pulse time. The condition is illustrated by Fig. 2. Losing one horizontal pulse now and then will not affect the horizontal sweep stability very much due to the flywheel action of the horizontal afc and horizontal oscillator. But loss of an appreciable portion of the vertical pulse groups will lead to vertical stability impairment (rolling, loss of interlace) far more rapidly. The black spaces in the picture information definitely tie the trouble to squegging though (see Fig. 2-b).

Multivibrators and blocking oscillators may squeg as well as sine-wave types. Stoppage of the vertical oscillator results in bright compressed lines where the trace has stopped. The brightness tapers off rapidly, but not immediately, as in conventional retrace and a part of the lower portion of the picture is missing. (The vertical oscillator does not drive itself into retrace but merely stops in this case.) Stopping of the horizontal oscillator results in loss of high voltage in flyback systems, and no line is visible during the dead period of the squeg. At high rates of squegging, the result may be a flicker. Examination under a magnifying glass will reveal the loss of video information if the local oscillator is at fault, or loss of all line structure if the horizontal oscillator is acting up (due to no high voltage).

Causes of squegging

Squegs are caused by circuit conditions that cut the oscillator tube off for a definite time, then turn it on again.

The most common cause is periodic cutoff. A grid-capacitor–grid-leak combination with too long a time constant is the most usual reason.

Fig. 3 shows how this happens in the Hartley oscillator circuit of Fig. 3-d. Oscillations build up rapidly (Fig. 3-a) and increase the negative grid bias developed across the grid resistor (Fig. 3-b), since the grid is driven positive each cycle and attracts electrons which have to leak off through R1. Increasing charge on the grid

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capacitor drives the tube to cutoff and holds the grid voltage at or near cutoff until enough electrons have leaked through R1 to permit oscillation to begin again. This is the dead period of Fig. 1-a.

The charge of the grid capacitor leaks off and the oscillations start again. The grid bias does not have to return to zero — only to a level that permits oscillations to start. The squeg cycle repeats itself.

Increase of the grid resistor value is the most common cause of a too-long time constant. Check with an ohmmeter or shunt the resistor with another. Less common is increase of the grid capacitor. Test by substitution or measurement on a capacitor checker. If an abnormally low value of shunt resistance (across the grid resistor) is needed to stop the squeg, increase in the capacitor is very likely.

Too much feedback can cause squegging. In the circuit of Fig. 3-d, the P-part of the tank coil induces a feedback voltage in the G-part. If this is excessive, the height (amplitude) of oscillations shown at Fig. 3-a will result in excessive grid bias (Fig. 3-b) and squegging.

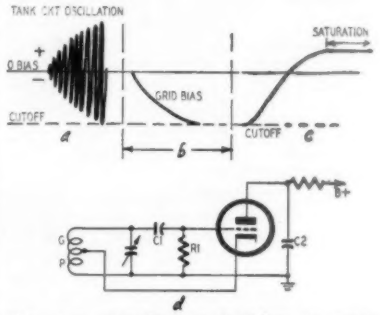

Fig. 3-a—Oscillatory buildup in tank circuit; 3-b—corresponding grid bias developed; 3-c—characteristic curve showing cutoff and saturation (see-text); 3-d—Hartley oscillator circuit for illustration.

Feedback voltage P is dependent on the position of the tap on the tank coil and the gain of the oscillator tube. Excessive B-plus voltage may be the cause—check it with a voltmeter. A new tube may cause a squeg as its mutual conductance may be too great in a critical circuit—tubes have a manufacturing tolerance like other components! The tap may have been misplaced ever so slightly in manufacture, so that the number of turns on the P-

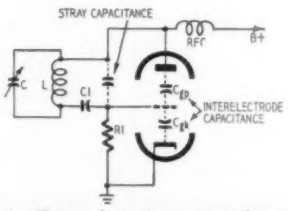

Fig. 4—Excessive stray capacitance in some oscillators may cause squegging.

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portion is too great. (A new coil is the usual remedy unless the tap can be moved.)

Improper dressing of the leads to tube electrodes (socket terminals) when making other repairs may result in a squeg. Fig. 4 is a typical oscillator circuit found in TV tuners. Feedback is through the interelectrode capacitance between plate and grid. There is some stray capacitance due to tube leads, pins, socket lugs, connecting wires, etc. But if this capacitance is abnormally increased by pushing the connecting wires too close together, a squeg can result.

Saturation squegging

In some types of oscillators, the "tube" of Fig. 3-d is plural—the feedback is taken over several stages. Should one of the tubes in the amplifier be driven into saturation and permitted to remain there for a period of time, then squegging will result just as if the tube were cut off. Since plate current cannot change in the saturation region (it is already maximum) no oscillatory feedback can occur and the input voltage on the grid cannot be maintained. Checking the grid bias on all tubes will reveal this condition, which is the result of too positive a bias on one or more grids. It can happen because of a leaking coupling capacitor—one of the more common causes of saturation squegging.

Shortwave oscillators

Some local oscillators on shortwave radio sets squeg only on the shortwave bands. A capacitor in series with the grid capacitor may be added to the bandswitch in many models to lower the time constant. The added capacitor is necessary on some of the shortwave bands only in most of such cases.

Multivibrator squegging

Multivibrators and blocking oscillators may present symptoms resembling squegs that are not true squegs. (Normal blocking oscillator operation is actually a form of controlled squegging.) Any intermittent operation will cause an effect resembling squegging.

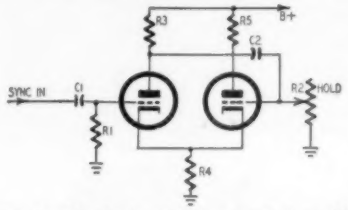

Fig. 5—Typical cathode-coupled multivibrator circuit to illustrate true and apparent squegs in this type of oscillator.

First, see that the tube itself is not intermittent (substitute). Then check for possible poor contact on the variable resistor that acts as a frequency control (hold control in TV sweep generators).

In Fig. 5 for example, intermittency could result from poor contact of the slider arm of R2 (hold) or intermittent opening of C2 (coupling capacitor). Such would resemble squegging with the same symptoms.

Increase in value of either C1 or R1 of Fig. 5 will result in a true squeg. So too will appreciable change of the values of R3 and R4, which operate in conjunction with C2 and R2 to flip the multivibrator over. These components control the regeneration or recycling of the right tube. R4 and R5 control recycling of the left tube in addition to the amplification of the tube itself.

Blocking oscillators may squeg (apparently) due to any intermittency in their components. As in the case of multivibrators, the time constant of a grid circuit may be altered but this symptom will show up as too low a frequency of sweep just like excessive values of either C2 or R2 in the multivibrator circuit of Fig. 5. Here one has the trouble of low sweep frequency rather than squegging as the symptom.

The rather high peak voltages of the waveshapes on components in both multivibrator and blocking oscillator circuits tend to produce intermittents as described above. The best way to be sure is to substitute parts—particularly the capacitors—in such circuits rather than spend too much time trying to locate a defective one. END

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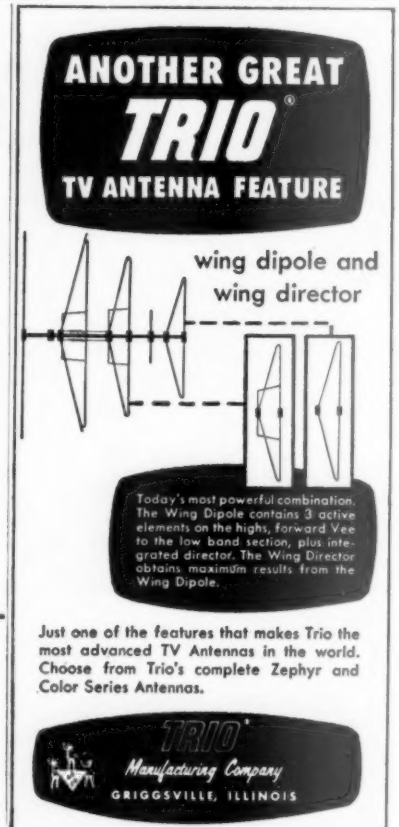
Here are popular, fast moving capacitors which mean repeat business for you. They withstand extreme moisture and temperature conditions. Made of highest quality and unconditionally guaranteed for one year, these attractively-priced capacitors are packaged in eye-appealing boxes.
INTE—Flexible Lead Types Heavily Waxed Cardboard Case
IHCE—Tubular Types Aluminum Case
ILLINOIS "UMP" and "ELECTROMITE" Capacitors are available from leading electronic parts distributors.
ILLINOIS CONDENSER COMPANY
1616 NORTH THROOP STREET
CHICAGO 22, ILL. EV 4-1300
Export Department: 15 Moore Street, New York 4, New York
Write for our complete catalog.


ANOTHER GREAT
TRIO®
TV ANTENNA FEATURE
wing dipole and wing director
Today's most powerful combination. The Wing Dipole contains 3 active elements on the highs, forward Vee to the low band section, plus integrated director. The Wing Director obtains maximum results from the Wing Dipole.
Just one of the features that makes Trio the most advanced TV Antennas in the world. Choose from Trio's complete Zephyr and Color Series Antennas.
TRIO® Manufacturing Company
GRIGGSVILLE, ILLINOIS

TECHNICIANS' NEWS

SET OWNERS SURVEYED

Fifteen students at Wayne State University in Michigan, under the direction of Dr. H. W. Johnson, interviewed 372 TV set owners in 15 areas of Detroit early this year, asking questions about set ownership and repairs. Answers showed that almost 25% of the people had two TV sets. RCA's made up 16.8% of the sets in the homes canvassed, Admirals 14.1, Motorola's 11.8, G-E's 8. Philco, Muntz, Zenith and Westinghouse accounted for another 25% and the remaining 24% was scattered among 30 brands.

The survey also found over half the people stating they had their sets turned on from 2 to 5 hours each day, and about 40% saying their sets were on for more than 5 hours a day.

Almost half the people had had receivers repaired during 1958, and 30% said they'd had service in the first 3–4 months of 1959. About 13% said they'd had service in 1957 but not since, while 9% had never had any service.

One-third chose their service technician on advice of a friend, and just under one-quarter said they chose a neighborhood shop, while just over one-fifth stated that they took their set dealer's recommendation. About 9% went by the yellow pages of the telephone book. But 43% said they ended up with a local shop, while 16% used "free-lance servicemen." Another 11% used the dealer who sold the set, and 10% used factory service.

In one-third of the cases the sets had been pulled. Over 90% said the repair work was finished promptly. In 84% of the repairs some tubes were replaced, and in one-third there were other repairs. Although 88% felt that their repairs had been handled honestly, 11% felt that the prices charged had been too high. A large majority, 83%, declared themselves satisfied with past service; 23% felt $3 was a fair price for a service call, 25% thought $4 was OK, and 24% said $5 was all right.

TECHNICIAN JAILED

A St. Paul (Minn.) repair technician, Ernest Eisenhower of 535 Goodrich, was jailed on charges of obtaining money under false pretenses when he failed to appear in court for trial.

He was first arrested following a repair job performed for a St. Paul resident. His bill for $41.50 included $27.50 for cleaning the tuner and $5.40 for changing a coil. The city prosecutor's office alleged he did neither.

When arrested, Eisenhower appeared before Judge Archie Gingold and was released for trial the following Wednes-

The RCA Kit Parade

PRESENTS...

A new RCA-WV-77E(K) VoltOhmyst® for only $29.95*

Also available factory-wired and calibrated—RCA-WV-77E VOLTOHMYST—only $49.95*
*User Price (optional)

FREE—New Booklet, "Servicing Is Easy With An RCA VoltOhmyst" offered with the purchase of a WV-77E(K) or WV-77E ($1 value).

Hams! Hobbyists! Service Technicians!—Here's the new RCA VoltOhmyst Kit you've been hearing about ...combining dependable electronic performance and ease of assembly!

Look what you get—ohms-divider network protected by fuse—ultra-slim probes and flexible leads for getting into those tight spots—leads, probes, and power cord can be stored in sleeve attached to handle for increased portability—separate scales for 1½ volts rms and 4 volts peak-to-peak maintain instrument accuracy on low ac measurements—all lettering on front panel acid-etched to last the life of the unit!

You can get the new RCA VTVM Kit at your local RCA Test Equipment Distributor today—it's available "off-the-shelf"! For literature, visit your nearest RCA Distributor, or write RCA Commercial Engineering, Section Harrison, N. J.

SPECIFICATIONS

Measures:
DC Volts—0.02 volt to 1500 volts in 7 overlapping ranges
AC Volts (RMS)—0.1 volt to 1500 volts in 7 overlapping ranges
AC Volts (peak-to-peak)—0.2 volt to 4000 volts in 7 overlapping ranges
Resistance—from 0.2 ohm to 1000 megohms in 7 overlapping ranges. Zero-center indication for discriminator alignment
Accuracy—±3% of full scale on dc ranges; ±5% of full scale on ac ranges
Frequency Response—flat within ±5%, from 40 cycles to 5 Mc on the 1.5, 5, and 15-volt rms ranges and the 4, 14 and 40-volt peak-to-peak ranges
DC Input Resistance—standard 11 megohms (1 megohm resistor in probe)

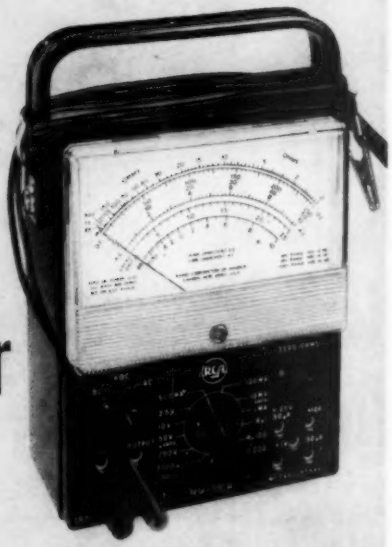
RCA® RADIO CORPORATION OF AMERICA
Electron Tube Division Harrison, N. J.

The RCA Kit Parade

PRESENTS...

A New RCA Volt-Ohm-Milliammeter

...special ranges for transistor servicing!



RCA WV-38A(K) VOM Kit
ONLY $29.95* (includes internal batteries, probe and cable with slip-on alligator clip, ground lead and clip, assembly and operating instruction booklets)
*User Price (Optional)

RCA WV-38A VOM
ONLY $43.95* completely wired and calibrated

EXCLUSIVE! Extra 1-volt and 0.25-volt (250 mv) ranges permit wide applications in transistor servicing!

EXCLUSIVE! New handle clips accommodate probes and test leads for extra carrying convenience!

EASY ASSEMBLY...

★ mount six components on the front panel
★ mount all other components on one side of laminated circuit board
★ put panel and circuit board together
★ slip on the knobs!

Never so many valuable features packed into a VOM!—Ohms-divider network fuse-protected. Easier-to-read scales! Extra-large 5¼-inch meter. Polarity reversal switch. Improved frequency response. Full-wave bridge rectifier. Less circuit loading. Standard dbm ranges. PLUS—modern styling—it's an instrument you'll be proud to "show off!"

WV-38A SPECIFICATIONS

Input Resistance	• 20,000 ohms per volt on DC 5,000 ohms per volt on AC
Accuracy	• ± 3% DC, ±5% AC (full scale)
Regular Scales	• 2.5, 10, 50, 250, 1000, 5000 volts, AC and DC • 50 μa, 1, 10, 100, 500 ma, 10 amps (DC)
Extra Scales	• 250 mv. and 1 volt (dc)
Frequency Response	• AC—flat from 10 cycles to 50 Kc (usable response at 500 Kc)
Ohms	• 3 ranges: Rx1—(0-2,000 ohms), Rx100 (0-200,000 ohms), Rx10,000 (0-20,000,000 ohms)
Dimensions	• W. 5¼", H 6⅞", D 3⅛"

See it at your local RCA Test Equipment Distributor!

RCA **RADIO CORPORATION OF AMERICA**
Electron Tube Division *Harrison, N. J.*

day. When his case came up, Eisenhower was not present and presiding Judge Keyes issued a bench warrant for his arrest. Police brought him to the courtroom where a new trial date was set and his bail increased from $25 to $200. He couldn't furnish bail and was taken to the city jail to await trial.—*NATESA Scope*

DO YOU BELONG TO A SERVICE TECHNICIANS' ASSOCIATION?

For the benefit of service technicians and their organizations RADIO-ELECTRONICS is publishing a complete list of the known television service associations in this country and Canada. Due to the difficulty of contacting associations, our first lists will necessarily be incomplete and sometimes inaccurate. Service technicians can help us put out a complete up-to-date list. If you know of any association omitted from our list, or can correct any of the old listings, please write to: Association Editor, RADIO-ELECTRONICS, 154 W. 14 St., New York 11, N. Y.

This month we publish a list of known local associations in Pennsylvania. We will list locals in other areas in subsequent months. If there is a group near you, why not contact them. It's for *your* benefit.

To learn of the association nearest you *now*, drop a postcard to: Association Editor, RADIO-ELECTRONICS, 154 W. 14 St., New York 11, N. Y.

FEDERATION OF TELEVISION-RADIO SERVICE ASSOCIATIONS OF PENNSYLVANIA, INC.
67 South Main St.
Carbondale, Pa.
Leon J. Helk, Secretary

ELECTRONIC DEALERS ASSN. OF WESTERN PA., INC.
6026 Station St.
Pittsburgh 6, Pa.
Joseph Simandl, Secretary

ELECTRONIC TECHNICIANS ASSN. OF LANCASTER COUNTY
Box 264
Ephrata, Pa.
Gilbert L. Sweigart, Secretary

LACKAWANNA RADIO & TELEVISION TECHNICIANS ASSN.
2224 Capouse Ave.
Scranton, Pa.
John F. Roche, Secretary

LEHIGH VALLEY ELECTRONIC ASSN.
889 N. Graham St.
Allentown, Pa.
John Zeigler, Secretary

LOWER BUCKS COUNTY TELEVISION SERVICE DEALERS ASSN.
1624 Newportville Rd.
Corwell Heights, Pa.
Edward Zychal, President

LUZERNE COUNTY SERVICEMEN'S ASSN.
Box 309
Wilkes-Barre, Pa.
Milan Krupa, Secretary

TELEVISION SERVICE ASSN. OF DELAWARE VALLEY
4710 Old York Road
Philadelphia 41, Pa.
Lewis J. Smith, Secretary

TELEVISION SERVICE DEALERS OF DELAWARE COUNTY, INC.
Box 355
Chester, Pa.
Leon Skalick, Secretary

COLLECT BY TELEPHONE

From the *TESA News* (St. Louis), comes this suggestion on collecting overdue bills: "The average television service company has its service manager or owner as part-time collection department. Many times one phone call will do the work of several written notices and statements. Strength of the telephone for collection purposes lies in 'facing the matter out'—in having a two-sided discussion of the subject. A personal call by telephone compels some kind of answer, some promise, as only a small percentage of people are dishonest."

TESA lists these points to follow:

"1. Be sure to talk to the right person.

"2. Begin by telling who you are and review the bill, the time, the situation.

"3. Listen to the customer's explanation for nonpayment. There may have been an unusual condition—illness, vacation, etc. Watch for a possible complaint about product or service.

"4. Ask what payment date he will agree to. Get an exact date. Record this date. If payment is not made on that date, follow up immediately with a call.

"5. Don't sound antagonistic. *Do not be angry or irritated.* Do not joke. Be firm and businesslike."

ILLINOIS LICENSE BILLS

From Chicago, the Associated Radio & TV Servicemen report that two bills aimed at service technician licensing, one a state-wide measure and the other geared specifically to regulate Chicago technicians, were defeated. ARTS said that it "fought both of these efforts against odds, but with the . . . support of more than 160 Illinois servicemen . . . . This is the third time that ARTS has fought and beaten licensing legislation in the state."

CORRECTION

The principal speaker at the banquet held during the recent Electronics Technicians Forum in Philadelphia was Mr. Gale Carter, executive secretary of the National Electronics Distributors Association, not Mr. Donald H. Stover as stated in the August issue. Our thanks to Dave Krantz of the Pennsylvania Federation for this correction.

OHIO INDEPENDENTS OPPOSE

A city ordinance which has been proposed to license radio–TV service technicians in Middletown, Ohio, was opposed at a meeting of the Middletown City Commission by 33 men who said they serviced television receivers and radios. The proposed licensing had previously been supported by the Television & Electronics Service Association, according to published reports.

ID CARDS FOR DEALERS

The George D. Barbey Co., Inc., components distributor of Reading, Pa., has decided to serve only the service technician who presents an identification card. The company checks the informa-

The RCA Kit Parade

PRESENTS...

A new RCA Oscilloscope

higher gain...
wider bandwidth
for greater value!

RCA WO-33A (K)
3-Inch Oscilloscope Kit

ONLY $79.95* (complete with Low-Cap/Direct Input Probe and Cable)

RCA WO-33A
3-Inch Oscilloscope

ONLY $129.95* completely wired and calibrated

*User Price (Optional)

When you buy a scope...this is the scope for you! Whether you're a technician, electronics hobbyist, ham, or an electronics engineer, the WO-33A will give you what you need in gain, bandwidth, transient response, accuracy, versatility, portability! AND...you can take it with you—on the job—anywhere!

★ ***for ACCURACY***—voltage calibrated frequency-compensated, 3-to-1 step attenuator.

★ ***for MEASUREMENTS***—scaled graph screen and calibrating voltage source allows direct reading of peak-to-peak voltages.

★ ***for STABILITY***—"Plus-Minus" internal sync...holds sync to 4.5 Mc.

★ ***for COMPLETENESS***—shielded input cable with low-capacitance probe included.

★ ***for PORTABILITY***—compact size—W 6½" x H 8¾" x D 10¼"—weight only 14 pounds. Plus built-in brackets to hold power cord and cables.

Here's the "all-purpose" scope! All the bandwidth you need for servicing color-TV, video broadcast monitors and cameras; and for square-wave testing of audio and ultrasonic equipment! All the gain you need for low-level audio work—servicing pickups, microphones, preamps; plus signal tracing radios, amplifiers—trouble shooting communications signaling systems, ham radio and hi-fi equipment, industrial electronics machinery and many other applications.

WO-33A SPECIFICATIONS

Vertical Amplifier Narrow Band Position	
Sensitivity	• 3 rms mv/inch
Bandwidth	• within −3 db, 20 cps to 150 Kc
Vertical Amplifier Wide Band Position	
Sensitivity	• 100 rms mv/inch
Bandwidth	• within −3 db, 5.5 cps to 5.5 Mc
Vertical Input Impedance	
At Low-Cap cable input	• 10 megohms, 10 μμf (approx.)
At Direct-cable input	• 1 megohm, 90 μμf (approx.)
Sweep Circuit	
Sawtooth Range	• 15 cps to 75 Kc
Sync	• external, ± internal
Line Sweep	• 160° adjustable phase

See it at your local RCA Test Equipment Distributor!

RADIO CORPORATION OF AMERICA
Electron Tube Division — Harrison, N. J.

tion submitted by prospective customers to be sure he's "legitimate" and then issues the identification card. The distributor's manager, Sydney A. Reber, said that many of his dealer–customers have complained with good reason that their own customers have been able to buy tubes and parts in the past at wholesale prices.

"PART-TIMER'S EVIL"

In the *NATESA Scope*, monthly publication of the National Alliance of Radio–TV & Electronic Service Associations, executive director Frank Moch says in part, "During the Nashville meeting I talked to dozens of NATESA people who expressed concern for the plight of legitimate ethical operators of home electronic service businesses . . . tougher each day . . . volume of service is going down . . . stretching their work day . . . they have reached the limit. . . .

"Obviously the cause in all cases is the part-time servicer. These are now outnumbering the legitimate *business* operators by as much as 20 to 1. It appears that whenever a person needs a few extra dollars or gets laid off from any job, he seeks to make ends meet in TV service. Having *no* overhead and assuming no responsibility, his rates are far below those *needed* by a business establishment. We should all recognize the part-time servicer as *the* No. 1 problem. How can you compete with a man who works after normal hours, Sundays and holidays, and has no overhead or responsibilities . . . ?

"The best answer is licensing by the states, since only in this way can you expect that a reasonable degree of proper assumption of necessary costs and obligations will put all competitors on an equal starting basis . . . . Failing the establishment of licensing in your area, I urge you to adopt self-licensing, such as was developed by TESA–Chicagoland. Use every applicable tax and other agencies to force the part-timer to assume his proper burdens . . . ."

FREE! WITH EVERY 12-PAK ORDER

YOU GET THIS

8 IN ONE PAKette

Worth $10.00—Lektron's Introductory PAKette

Includes 8 categories: transistor, diodes, volume controls, resistors, disc-ceramic-tubular condensers, hook-up wire—all pre-packed in 8-compartmented carryall to save you money!

FREE! NEW GIANT BARGAIN CATALOG Best in Electronics YEAR'S SUBSCRIPTION

Lektron's Exclusive Poly Paks! Formerly $1.00 Per Pak!

750,000 Poly Pak° Sold

15-PC. DRILL SET ☐ 1/16" thru 1/4" x 64ths, w/calibrated case. Reg. $3. **88¢**

MINI GEIGER COUNTER TUBE. ☐ Dozens of radiation detection uses. 2" long, 1/2" dia. **88¢**

16-END WRENCH SET ☐ Box & open: 15/64 thru 7/16". Reg. $2.50 set. **88¢**

40 HI-Q CONDENSERS ☐ Finest porcelain. NPO's, too. 1 lb. Reg. $15. **88¢**

4 POWER WOOD BITS ☐ Hi-Q steel, 3/8, 1/2, 3/4, 1", 5" long. Reg. $3. **88¢**

2 TRANS'T'R VARIABLES ☐ 11/4" sq., 2" shaft. Dual 365 mmf. 1 lb. Reg. $3. **88¢**

18 'SEALED' CIRCUITS ☐ Built - in resistor - condenser coupling circuits for subminit. 1-lb. Reg. $9. **88¢**

3 GERMANIUM DIODES ☐ Glass-sealed, w / long leads. For hobby projects. **88¢**

20 HI-Q MOLDED OILS ☐ Used in finest commercial-gov't equip; .1-mf to 1-mf to 600V, 3-lbs. Reg. $40. **88¢**

35 DISC CONDENSERS ☐ Wafer-thin; up to 3000VDC. Reg. $5. **88¢**

20 PILOT LIGHTS ☐ Popular flashlight sizes; mini, bay & screw types. 2 to 6V. Wt. 1 lb. **88¢**

JEWELERS SCREWDR'V'RS ☐ Set of 5; dif. sizes. ☐ Precision made, for sub-miniwork. Wt. 1 lb. **88¢**

60 MICA CONDENSERS ☐ .00025 to .01 to 1200 V. Silver too. 25 values. Reg. $28. **88¢**

38 TUBE-SOCKETS ☐ 4 to 9-pin; shield-based incl. 2 lbs. Reg. $10. **88¢**

70 TBLR CON'N'SRS ☐ Paper, molded; to .5 mf to 1000V. 2-lbs. Reg. $14. **88¢**

WIRE STRIPPER ☐ Strips, cuts #16 thru #22 hookup. Wt. 1 lb. **88¢**

2 NPN TRANSISTORS ☐ Used in popular make radios. Worth $5.00 **88¢**

30 POWER RESISTORS ☐ W.W. 5 to 50W, to 10K. ☐ Vitreous too! 3-lbs. Reg. $15. **88¢**

30 MOLDED COND'S'RS ☐ Assrtd. Finest made. Wt. 2 lbs. Lowest price. **88¢**

40 SUBMINI-RESISTORS ☐ 1/2" long. Asst. values, 1/2W to 10 megs. Reg. $6. **88¢**

60 CONDENSER SPCL! ☐ Molded, paper, ceramic, oil, mica, disc, variable; 2-lbs. **88¢**

10 ROTARY SWITCHES ☐ Assorted gangs. 3 lbs. Reg. $12 **88¢**

75 RESISTOR SPCL! ☐ WW, precision, carbon, variable, mini; 3 lbs. $15 val. **88¢**

40 PRECISION RES'T'RS Asst. carbon, W.W. ☐ 1%, 1/2, 1, 2W; 1 lb. Reg. $19. **88¢**

5" HOBBY SPEAKER ☐ For radios, code osc., intercoms; 2 lbs. Reg. $5. **88¢**

000-999 COUNTER ☐ Veeder-Root. Resets motors, coils, etc. Reg. $5. **88¢**

HEARING AID PHONE ☐ Crystal, w/cord set & plug. Reg. $5. **88¢**

60 RADIO-TV KNOBS ☐ Asstd. colors, insulation. 2 lbs. Reg. $17, many $1. **88¢**

2 VARI-LOOPSTICKS ☐ Adj. 540 - 1500 kcs. ☐ Transistor radios, etc. 1 lb. **88¢**

5-IN-1 DRILL BIT ☐ Reams, saws, copes, drills, shapes. Hand-power drills. **88¢**

$25 SURPRISE PACK! ☐ Large, varied assortment radio - TV parts. 3 lbs. **88¢**

300-FT. HOOKUP WIRE ☐ Tinned, asstd. sizes, colors. 2 lbs. Reg. $5. **88¢**

3 RCA PLUG-N-JACK ☐ Sets matched. Most popular. amps, tuners, phonos. **88¢**

70 HI-Q RESISTORS ☐ Insulated, carbon; 1% too. 1/2 & 1w, 10 ohms to 10 megs. 2 lbs. Reg. $13. **88¢**

4 OUTPUT XFMRS ☐ 50L6, etc. 3 lbs. Reg. $8. ☐ Save over 80%. **88¢**

2 TRANSISTORS IF'S ☐ Audible-tune; only 1/2" sq. 456 kcs. **88¢**

70 ONE-WATTERS ☐ Asstd. value carbon resistors. 5% too. **88¢**

88¢ EA.

MINI-RADIO KIT ☐ Loopstick, jacks, diode & instr. 1 lb. Reg. $3. **88¢**

POSTAGE STAMP MIKE ☐ Crystal, 100 to 6,000 cps. 1 lb. Reg. $7. **88¢**

6 SILICON DIODES ☐ Sylvania 1N22, 1N23. Reg. $36. **88¢**

60 TERMINALS STRIPS ☐ Solder-lug & binding. 10 types. 2 lbs. **88¢**

60 COILS, CHOKES ☐ IF, RF, ant., slug-tuned, too. 3 lbs. Reg. $15. **88¢**

10 ELECTROLYTICS ☐ Radio, TV. 10-500 mf to 450 VDC. 3 lbs. Reg. $12. **88¢**

5 ROLLS MICRO-WIRE ☐ #24 thru 32; for transistor, sub-mint. 1 lb. **88¢**

12-HR. 'SPACE' CLOCK ☐ Powered by penlite cell. 6oz. $8 val. Hobbyists! **88¢**

20 ARTISTS BRUSHES ☐ 100% pure bristle; sizes 1-6. Reg. $2.50. **88¢**

7-SCREWDRIVER SET ☐ Asstd. sizes; wall rack. ☐ 1 lb. $3.50 list. **88¢**

1500 PCS. HARDWARE ☐ Nuts, screws, washers, etc. 11/2 lbs. Reg. $6. **88¢**

3 TRANSISTOR XFMRS ☐ Submini size. 100 uses. ☐ Audio, etc. Reg. $10. **88¢**

35 TWO-WATTERS ☐ Carbon resistors; incl. 1%. Reg. $12. **88¢**

SUN BATTERY ☐ Similar to famed B2M, 1" long. Reg. $2.50. **88¢**

6 ROLLS OF TAPE ☐ Popular plastic friction, rubber, cellophane. 1 lb. **88¢**

$15 SEALED RELAY! ☐ Used in Jets; glass-sealed, 3PST cont. 6V DC coil. For precision circuits. 1 lb. **88¢**

10 POLY BOXES ☐ Clear plastic, hinged w/snap locks. ☐ Asstd. 1 lb. **88¢**

40 "SILVER" MICAS ☐ Finest made condensers, 1 to 5%. Asstd. values. Axial leads. 1 lb. Reg. $25, some $3 ea. **88¢**

15 MOLDED TIP JACKS ☐ Red; for multitesters, etc. Uses std. tips. 100 uses. **88¢**

6 SUB-MINI SOCKETS ☐ Mica-filled. For transistors, sub-mini. work. **88¢**

100 RESISTORS ☐ Carbon, precision: 1/2 to 2W. 1 & 5%, to 2 megs. 3 lbs. Reg. $25.00. **88¢**

HOBBY BENCH VISE ☐ Clamp type. Fits tables too. Steel. 1 lb. **88¢**

40 SUBMINI COND'SRS ☐ For transistor, printed circuits. 1 lb. Reg. $7. **88¢**

10 VOLUME CONTROLS ☐ Some w/switches. 2 lbs. Reg. $9. **88¢**

100 HALF-WATTERS ☐ Asstd. value carbon resistors, incl. 5%. $12-val. **88¢**

2 'flea' POWER MOTORS ☐ 11/2 to 6VDC; from penlite cells. Permamagn. 1 1/4"sq., 1" shaft. **88¢**

50 PLUGS/RECPT'CLES ☐ Audio, power, line, battery, spkr. 3 lbs. Reg. $7. **88¢**

2 SELENIUM RECT'F'RS ☐ AC-DC, 65 mil, for 110 VAC Circuits. Mfd. by Federal. **88¢**

2 WUERTH SURGISTORS ☐ Protects tube life in TV. Simple use, w/ built-in 10-sec. time delay. Reg. $2. **88¢**

4 OSCILLATOR COILS ☐ Mini, transistor. Covers 550 to 1600 kcs. Reg. $4. **88¢**

HOW TO ORDER Min. 2 paks per order

ORDER BY BLACK-TYPE HEADLINES, i.e., 20 HI-Q OILS, 88c. State price with each item. Send check or M.O. including sufficient postage; excess returned. C.O.D. orders, 25% down; rated, net 30 days. INCLUDE POSTAL ZONE in address. (Canada postage, 48c 1st lb.; 28c ea. additional lb.)

LEKTRON 131 Everett Ave. CHELSEA 50, MASS.

ORANGE CO. CERTIFIES

The California Society of Radio & Television Technicians, Orange County chapter, reports on progress in its "Approved Technician" program. Technicians must qualify through schooling or experience as well as by taking and passing an examination. After passing, they receive cards identifying them as Approved Technicians, and are supplied with gummed notices which they may stick to bills or put on the back of TV sets. The notices say, in part:

NOTE TO CUSTOMER

Mr. John Doe, who has serviced this TV receiver, has been classified an "Approved Technician" by the Orange County Chapter of the Society of Radio & TV Technicians, Inc., of California, after having passed a comprehensive examination given at Fullerton Junior College in April, 1959, and having to his credit at least 2 years of TV servicing experience . . .

WASHINGTON LICENSING

TV service technicians would be licensed in the District of Columbia under bill HR-7714, introduced by Rep. Foley (D, Md.), "to protect the public against abuse and fraud." Regulation of service technicians would cover "installation, maintenance, repair, replacement, testing, inspection and modification of TV and radio–TV receiving apparatus." Initial license fees: Contractors $25, technicians $15, apprentices $5.

ADDRESSES NATESA

Robert G. Middleton, television consultant to RADIO-ELECTRONICS and conductor of our Television Clinic, appeared on the program of the National Alliance of Television & Electronic Service Associations, Hotel Congress, Chicago, Aug. 20–23, as the representative of this magazine. His talk was entitled "New Technical Developments—What's Coming Next in Color TV." END

WANT A ROLLS-ROYCE?

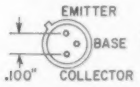
Shure Bros., Evanston, Ill., are giving a Rolls-Royce auto, to be awarded at the October New York High Fidelity Show, as the prize in a 25-words-or-less contest, "I like Shure stereo pickups because. . ." Blanks are available at Shure dealers; the contest was scheduled to end Aug. 31. The winner will also get a trip to England for two if he has bought a Shure pickup.

NEW TUBES and SEMICONDUCTORS

FROM mesa switching transistor to parametric amplifier diode to hi-fi output tube is the itinerary of our trip through this month's releases.

2N702

This high-speed switching transistor is an n-p-n diffused-base mesa silicon unit. It features a low saturation voltage, a guaranteed dc beta range and is packaged in a subminiature case.



Tentative design characteristics of the Texas Instruments transistor at 25°C are:

I_{CBO} (maximum) (μa) ($V_{CB}=10$, $I_E=0$)	0.5
BV_{CBO} (minimum) $I_{CBO}=10\mu a$, $I_E=0$)	20
BV_{CEO} (minimum) ($I_{CEO}=10\mu a$, $I_B=0$)	15
h_{FE} (minimum)	15
(maximum) ($V_{CE}=5$, $I_C=10$ ma)	45
BV_{EBO} (minimum) ($I_E=10\mu a$, $I_C=0$)	5
V_{BE} (maximum) ($V_{CE}=5$, $I_C=10$ ma)	1.2
V_{CE} (saturation) (maximum) ($I_C=10$ma, $I_B=2$ ma)	0.6

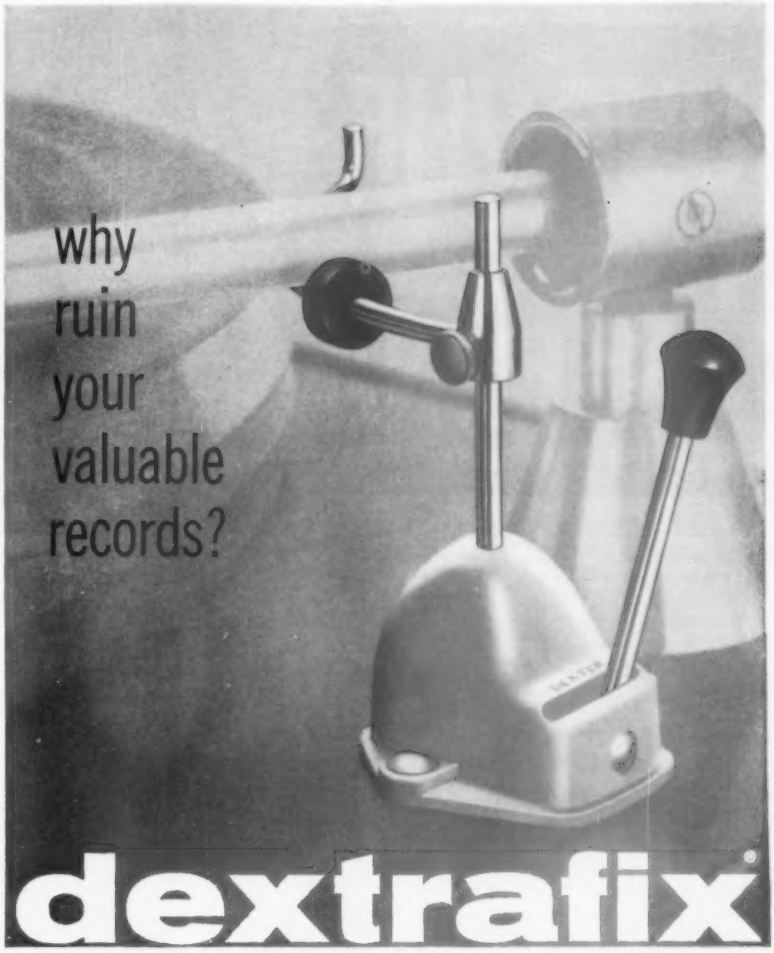
Parametric amplifier diode

Semiconductor diodes in a high-gain 3,000-mc parametric amplifier provide noise temperatures as low as 100° above absolute zero, operating at room temperature. The diode, made by Hughes Aircraft's Semiconductor Div., also has other microwave applications, such as switching and harmonic generation. It is available in two versions—one for below 1,000 mc and another for the microwave region.

The 3,000-mc parametric amplifier using the Hughes' diodes gives 30 db of amplification with a 2-mc bandwidth or 10-db amplification with a 25-mc bandwidth.

2N456, 2N457

Germanium p-n-p alloy junction transistors for power-switching, voltage-regulator, multivibrator, dc-to-dc converter, and power-supply circuits, and relay actuating devices in industrial and military equipment. They may also be used in large-signal class-A or



TONEARM CONTROL

lowers the tonearm into the lead-in groove... lifts it after play!

If the tonearm slips out of your fingers and bounces over the record—the record is ruined! If you're unlucky, you will also need a new stylus and possibly a new cartridge.

Why take a chance? DEXTRAFIX® TONEARM CONTROL prevents such accidents! It places the stylus in the lead-in groove—gently and accurately. Then, at the end of play or at any point on the record, it lifts the stylus from the record. And the stylus cannot touch the record until the lift bar is again lowered for the next play. The DEXTRAFIX® TONEARM CONTROL also facilitates "cueing" at any point on the record.

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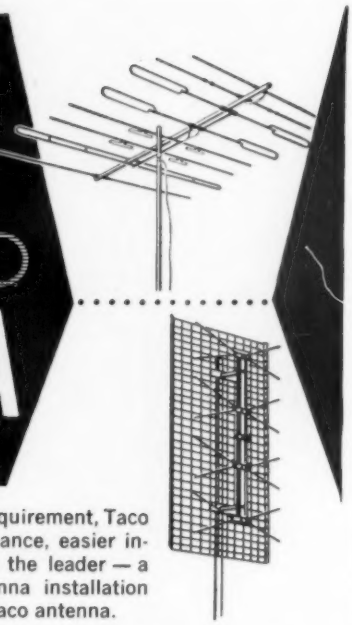

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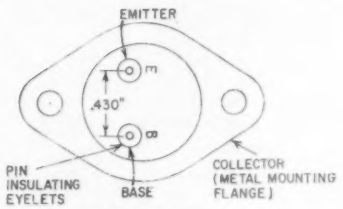
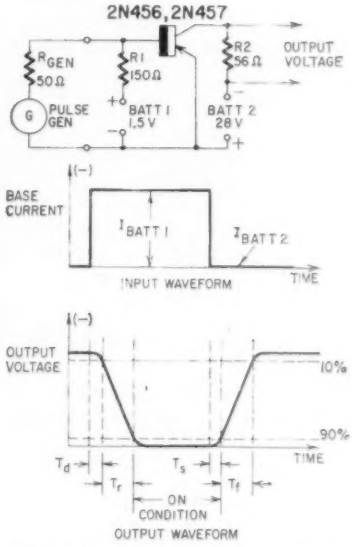


2N456, 2N457

class-B push-pull audio-frequency oscillator service.

Typical operating characteristics of these RCA transistors in the switching circuit shown are:

V_{supply} (BATT2)	28
$V_{base\ bias}$ (BATT1)	1.5
R_{gen} (ohms)	50
$R_{base\ bais}$ (R1) (ohms)	150
R_L (R2) (ohms)	56
I_{BATT1} (turn-on base current) (ma)	6
I_{BATT2} (turn-off base current) (ma)	0
Switching time	
T_d (delay time) (μsec)	10
T_r (rise time) (μsec)	130
T_s (storage time) (μsec)	25
T_f (fall time) (μsec)	85
P_{total} (mw)	123
G (db)	33.7
Efficiency (%)	99.3
Power output (watts)	13.1



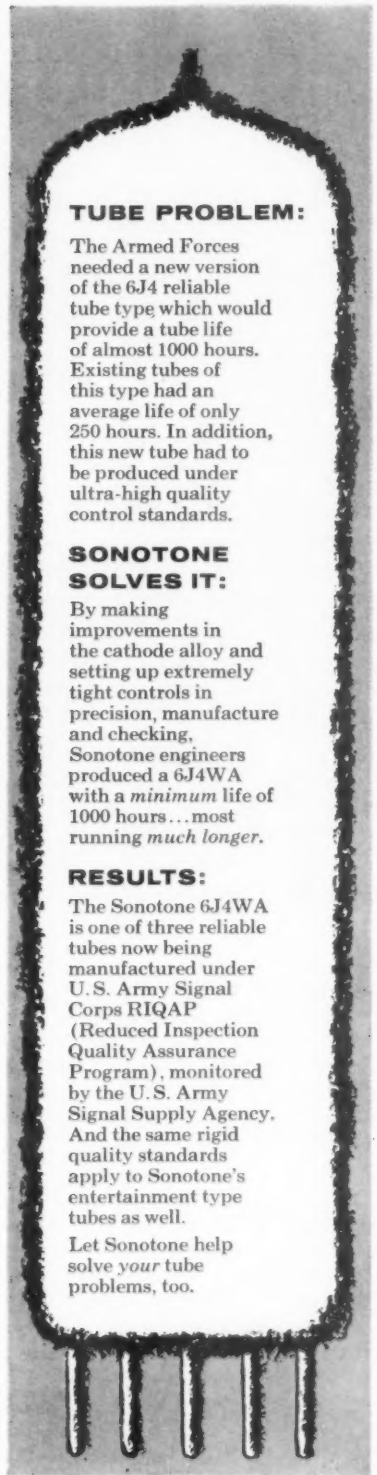
The 2N457 differs from the 2N456 in that it has a higher maximum peak collector-to-base voltage rating and higher breakdown voltage ratings.

2N1191, 2N1192, 2N1193

These germanium p-n-p alloy junction transistors are designed for general-purpose applications in the audio-frequency range, including both amplifier and switching service.

Maximum ratings of these Motorola transistors are:

BV_{CBO}	40
BV_{CER}	25
BV_{EBO}	25
I_C (ma)	200
P_C (mw) (in free air)	175



TUBE PROBLEM:

The Armed Forces needed a new version of the 6J4 reliable tube type which would provide a tube life of almost 1000 hours. Existing tubes of this type had an average life of only 250 hours. In addition, this new tube had to be produced under ultra-high quality control standards.

SONOTONE SOLVES IT:

By making improvements in the cathode alloy and setting up extremely tight controls in precision, manufacture and checking, Sonotone engineers produced a 6J4WA with a *minimum* life of 1000 hours... most running *much longer*.

RESULTS:

The Sonotone 6J4WA is one of three reliable tubes now being manufactured under U.S. Army Signal Corps RIQAP (Reduced Inspection Quality Assurance Program), monitored by the U.S. Army Signal Supply Agency. And the same rigid quality standards apply to Sonotone's entertainment type tubes as well.

Let Sonotone help solve *your* tube problems, too.

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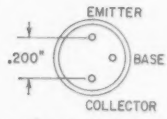


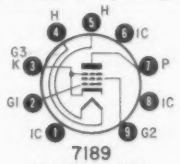
2N1191
2N1192
2N1193

Operating characteristics in a common-emitter circuit are:

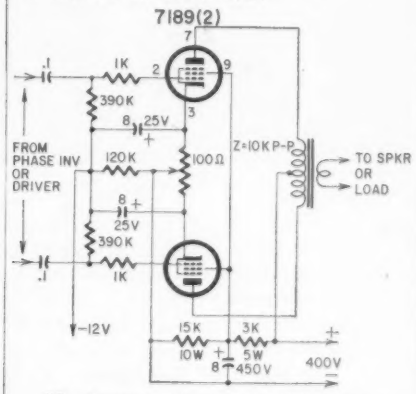
	2N1191	-92	-93
h_{FE} (maximum) (V_{CE}=6, I_E=1 ma, f=1 kc)	70	125	250
G_e (typical) (db) (V_{CE}=6, I_E=1 ma, f=1 kc)	42	44	46
NF (typical) (db) (V_{CE}=4.5, I_E=0.5 ma, f=1 kc, R_S=100 ohms)	10	10	10

7189

A miniature beam-power amplifier featuring high power output and power sensitivity. Two of these CBS-Hytron tubes, operating in push-pull with a



peak af input of 29 volts (grid-to-grid), provide 24 watts. The tube has a 6.3-volt 760-ma heater.



Maximum ratings of the 7189 are:

V_P	450
V_{G2}	300
V_{G1} (neg)	100
P_P (watts)	12
P_{G2} (peak) (watts)	4
(average) (watts)	2
I_K (average) (ma)	65
R_{G1} (fixed bias) (megohms)	0.3

END

INTERFERING FINANCE

The FCC received a complaint of poor TV visibility by 60 families sharing the master TV receiving antenna on a Connecticut apartment building. Inquiries revealed that the trouble extended over an area containing 500 receivers. An FCC engineer found it was caused by a defective flashing neon sign in the window of a local finance company. The manager (not because of financing any of the sets involved) immediately turned the sign off and arranged to have it repaired.—*Kilocycling With FCC*

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How far can you go in electronics without a degree?

A few years ago, Lincoln E. Kitchin had no formal degree and knew nothing about electronic computers.

He still doesn't have a degree, yet today, he is a Field Engineer on one of America's biggest electronics projects. He helps maintain one of the largest computers in the world. He's doing work ordinarily done by engineers—an opportunity usually denied to men without a degree. This is a story of unusual significance to every technician who feels himself handicapped by lack of a formal degree.

"It all started back at the Base," Link Kitchin recalls, "about two years ago. We were having lunch. One of my fellow Aircrewmen described an interview he had just had—with IBM.

"It sounded good to me—particularly the field engineering aspects. I wasn't anxious to start my civilian electronics career stuck in a corner of some plant. Here was a chance to work in the field—with all the advantages of a permanent location. I made a note to add IBM to the companies I was considering for civilian work."

Taking notes in IBM Field Engineering class | *Discussing a SAGE display console* | *Front view of computer frame*

Interviewed by IBM

A month later, Link Kitchin sat across the desk from an IBM interviewer. "Frankly," he confesses,"I was scared at the thought of this interview. I didn't know the difference between an analog and a digital computer. I didn't expect to get the job."

The interviewer put him quickly at his ease. A check of his background revealed his Service training—28 weeks of Class "A" aviation electronics plus Class "C" schooling in LORAN, RADAR and SONAR. He took a test which indicated excellent aptitude for computer work.

Then he learned how IBM would train him in electronics —for 20 weeks at full salary—to become a Field Engineer on the SAGE program. He learned about SAGE, part of our nation's radar defense net, which is built around giant IBM computers. He heard about IBM's excellent company benefits, especially interesting to Link Kitchin who had a wife and child. By the time the interview was over, he had decided that IBM and the SAGE program were what he was looking for. He decided then and there that he wanted to come with IBM.

Receives 20 weeks' training

Link Kitchin reported to Kingston, N. Y., for training. In the IBM "school," he studied basic computer circuits, computer logic and programming, card punch machines —all part of the twenty week course a Computer Units Field Engineer takes. "The instruction was excellent," he recalls. "Our teachers, experienced field men, often made points not in the textbook." Formal classroom lectures accounted for half his time, the other half being spent in the laboratories, where he worked on actual computer equipment for SAGE. During his training period, he received a living allowance in addition to his salary and overtime pay.

Assigned to site in home state

His twenty weeks' training completed, he was assigned to the SAGE site at Topsham, Maine. "IBM makes every effort to assign you to a location of your choice wherever possible," Link Kitchin, who is a native State-o'-Mainer, points out.

At Topsham, he has completed the installation phase of the computer. Now his work consists of preventive maintenance and "keeping the customer happy"—the customer, in this case, being the Air Force personnel who man and operate the computer. "Installing this giant computer was a significant engineering feat. First we ran 2,509 cables from 4 to 300 feet long. Then we bolted the computer sections together and hooked up the cables. Next came the testing phase in anticipation of Air Force acceptance tests.

A problem in pluggable units — Working on manual input board of SAGE computer — Recording data on main core memory unit

"I'm in the Display Group which has responsibility for over one hundred display consoles," Link Kitchin continues. "Each of these has a 19-inch and a 5-inch cathode ray tube (similar to a TV tube) plus associated circuits. The knowledge of complex circuitry which we learned in the IBM school is essential for this work. We also maintain our own test equipment—oscilloscopes, meters, signal generators and specially designed pluggable unit test equipment."

What does the future hold?

Link Kitchin looks forward to a rewarding career as a Computer Units Field Engineer. Promotion-wise, he could become, with further training, a Computer Systems Field Engineer, a Group Supervisor or Group Manager. Most important, however, he believes, is the excellent electronics background he's acquiring for the years ahead. 'I've had a new engineering dimension added to my career —thanks to IBM's willingness to spend time and money training technicians to assume engineering responsibilities."

A career for you with IBM?

Since Link Kitchin joined IBM and the SAGE program, opportunities are more promising than ever. IBM will invest thousands of dollars in the right men to insure the success of the SAGE program.

If you have a minimum of 3 years' technical schooling—or equivalent experience—you may be eligible for advanced training for 20 weeks as a Computer Units Field Engineer. While training, you receive full salary and overtime pay plus living allowance before assignment to a permanent location.

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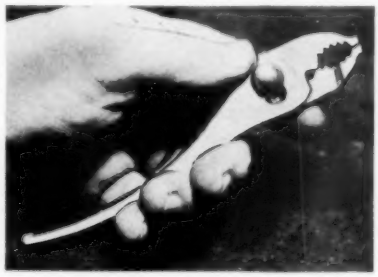
TOOL FOR TECHNICIANS

A pair of ordinary gas pliers can be turned into an extremely useful tool for the electronic technician by grinding off a goodly portion of the ends of the jaws as shown in the photograph. When



altered, the pliers will still hold a pin or similar part securely and can be turned easily in close quarters. The wide portion of the jaws will hold tubing, tighten larger bolts and nuts of the TV and radio chassis as well as do the work of special pliers. Add a rubber band to the handles and you will have a small vise for holding small parts to be soldered or adjusted.—*Glen F. Stillwell*

INTERMITTENT-SHORT DETECTOR

Solder a 0.5- to 2-amp auto light bulb across a burned-out fuse and insert it into the fuse clips of a TV set that is burning out fuses. Intermittent shorts are located by watching the bulb while jarring suspected components.—*Henry H. Josephs*

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TRY THIS ONE *(Continued)*

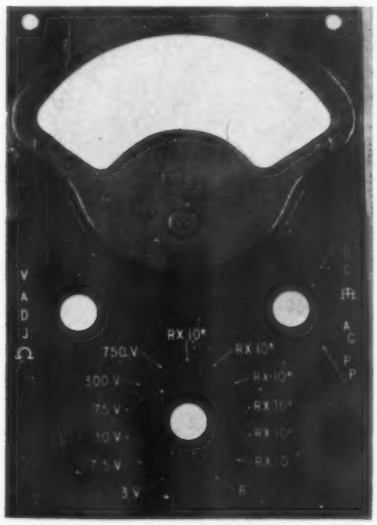
me one evening. And this is how I solved that particular problem.

I found that 3/16-inch outside diameter brass tubing has a ⅛-inch bore which corresponds to a hole just a bit smaller than a No. 30 drill. By squeezing the tube near the ends ever so slightly the bore was worked down enough to be threaded with a 6-32 tap. Almost any tool, a vise, pliers, etc., can be used to squeeze the tubing.—*John W. Sponsler*

MAKING FIRST-CLASS PANELS

You would like the appearance of that pet project to be all that it should. Here is a practical way to get the panel lettering.

1. Make a full-scale drawing of the required lettering on a sheet ½ inch



larger than the panel all around. This original may be a pasteup—letters or designs cut from catalogues, etc., and glued to the sheet. The edges of all such patches must be given a coat of white ink.

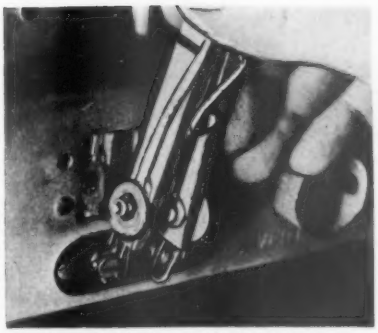
2. Get a very black, high-gloss negative photostat of the drawing.

3. Cement the photostat to the panel and trim off the edges.

The photo shows the results on a panel that has received this treatment—fully commercial in appearance. Three protective coats of clear floor varnish make it durable too.—*Milton White*

EMERGENCY ANTENNA CONNECTOR

If you are fresh out of antenna connectors for TV or radio, you can quickly make a satisfactory substitute from a spring type clothespin. Drill a small hole in each handle end of the clothespin and to these holes, by means of small machine bolts, fasten ordinary paperclips with their ends projecting about ½ inch as in the photo. Fasten antenna leads to the other ends of the paper clips and the device is complete. To use, merely squeeze the clothespin



together at the top and place it between the antenna connections on the TV. It saves time and trouble.—*Frank S. Guessman*

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So our trio of technicians would keep their service trucks out of accidents and out of the repair shops, we developed a fool-proof incentive plan that has seen the past 12 months go by without any accident save one very minor mishap. Each of our three men gets an extra day of paid vacation for each 3-month period he drives without an accident of any kind. This is the third year of the plan's operation, and each year has seen our safety record bettered.—*Harry J. Miller*

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cost. The upright from such a lamp can be quickly converted into a mike stand for professional or amateur use. To convert the lamp, remove and discard all parts except the base and the inner and outer upright tubing. To the top end of the outer tubing fasten a small platform for the mike. Between the inner and outer tubing use a length of discarded garden hose. The garden hose, if standard size, will fit snugly around the inner tubing and inside the outer tubing. Then, the outer tubing with its attached mike platform can be moved up and down easily, but will stay where you set it. Makes an attractive adjustable mike stand for use anywhere.—*William S. Frank*

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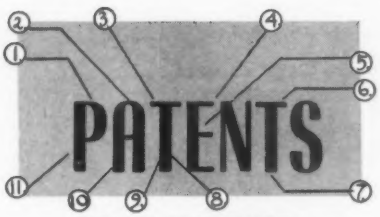
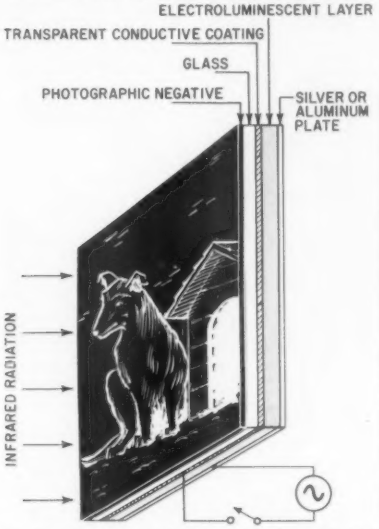


IMAGE INVERTER

Patent No. 2,883,556

Dietrich A. Jenny, Princeton, and Egon E. Loebner, Belle Mead, N.J. (assigned to RCA)

This device makes it possible to observe a positive image directly from a photographic negative. The negative is placed against a glass plate and irradiated with infra-red for a few seconds. The infra-red passes through the negative and falls



on an electronic cell. The negative and the infra-red are then removed and the cell is energized by ac. A positive image is then visible on the cell.

The electronic cell comprises 2 electrodes. One is a metal plate of silver or aluminum, and the other is a transparent conductive coating. Between them is an electroluminescent layer of zinc sulfide embedded in plastic. Normally the layer glows when energized by ac which may range from 80 to 2,000 volts at a frequency of a few cycles to 5 mc.

Infra-red light will quench this glow. Where it has passed through the negative, the cell cannot glow. Thus the dense portions of the negative correspond to light areas on the cell, and vice versa.

PULSE COUNTER

Patent No. 2,873,388

Donald E. Trumbo, Pleasant Hill, Calif. (assigned to USA as represented by US Atomic Energy Commission)

This circuit (Fig. 1) counts a series of pulses. For example, it can be set to indicate once for every 10 pulses.

Normally, diode D2 blocks BATT1. Transistor V is also blocked because it is isolated by D3. A

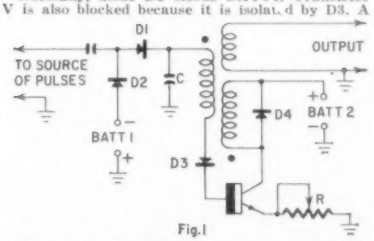


Fig.1

positive pulse from the source can pass through D1 and D3 to bias V for conduction. The transformer regeneration quickly builds up the signal until V conducts fully, and a surge of current flows through the collector winding. An induced voltage across the base winding puts a negative charge on capacitor C. Its voltage is controlled by resistor R, which determines maximum current through V. In any case, the voltage on C cannot exceed that of BATT1 because, if it does, current flows through D1 and D2 to reduce it.

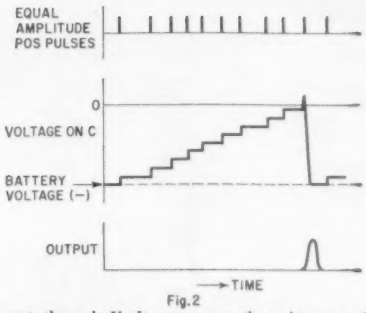


Fig.2

After the first pulse generated by V, oscillations tend to be set up, but they are damped out by D4. Therefore, D3 is blocked by C and the capacitor charge is trapped.

Succeeding pulses from the source pass through D1 and neutralize some of the charge on C. After a predetermined number of such pulses the original charge disappears and C starts to go positive. D2 conducts again, as does V, and another negative charge is deposited at C, etc.

The waveforms (Fig. 2) show how the positive pulses neutralize the negative charge on C, finally generating an output when the transistor conducts.

LONG-DISTANCE TV RELAY

Patent No. 2,875,436

John Hays Hammond, Jr., Gloucester, Mass.

It is not generally possible to transmit TV programs over long distances. While programs have been viewed over hundreds and even thousands of miles, these are remarkable exceptions. The limit is set by the characteristics of high-frequency waves, 50 mc or higher. In turn, a high carrier frequency is needed because the modulation frequencies run as high as 4 mc.

The problem may be solved as disclosed here, with the aid of video tape, now widely used for picture transcription. First, the TV signal (including sync, audio, etc.) is tape-recorded at

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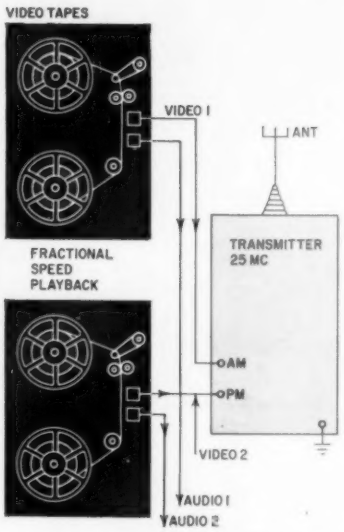


normal speed. The tape is then played back at low speed, say half, and used to modulate a multiplex transmitter. Playing back the tape slowly reduces the modulation frequencies and permits using a relatively low carrier, say 25 or 30 mc, for long-distance transmission.

To avoid doubling the time for transmitting the tape signal, each half of the program may be recorded on a separate tape and both sent simultaneously. For example, one tape may phase-modulate the transmitter while the other amplitude-modulates it. The sound may be sent via land wire or through another radio station.

On receiving the program, the stations record it on tape running at half-speed. The phase and the amplitude components of the signal are detected separately and recorded on separate tapes. Now when the 2 tapes are played back at normal speed and in proper sequence, the original program is available for local broadcast as usual.

This method eliminates the need for microwave relays or coaxial cables which are expensive and require frequent maintenance.

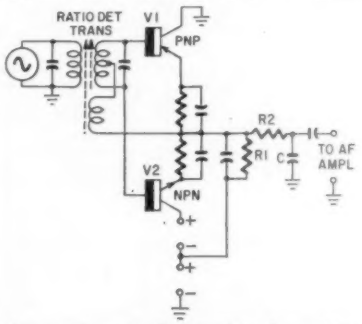
TRANSISTOR RATIO DETECTOR

Patent No. 2,878,384

David D. Holmes, Princeton, N.J. (Assigned to RCA)

This circuit limits, detects and amplifies. Its input network is a conventional ratio-detector transformer. V1 and V2 are energized by the voltage across the transformer secondary plus the quadrature component from the tertiary.

At the center frequency, equal and opposite



voltages appear at the transistor bases. Since V1, V2 are complementary, their conduction will be equal and opposite. Current flows from the center-tapped battery, V2, one side of which is connected to ground, through the emitter resistors, V1, return to ground. There will be no flow through R1.

If the frequency deviates, one transistor will conduct more than the other. The excess or differential must pass through R1, in one direction or the other. An FM signal will produce deviations and audio will appear across R1.

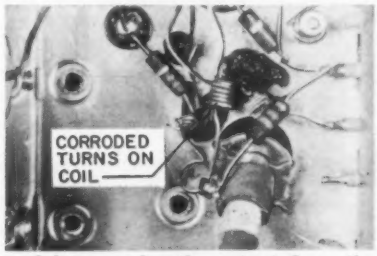
Resistor R2 and capacitor C comprise the de-emphasis network. END

Technotes

INTERMITTENT ADMIRAL

An Admiral receiver brought in to the shop had fluctuating contrast with intermittent loss of picture. The first guess was that it was age trouble, and override bias was applied to the age line. The symptoms were unchanged.

A scope was applied at the output of the picture detector and the trouble was evident here, with the waveform jumping through a wide range of peak-to-peak voltages. Using a sensitive de-



modulator probe, the output from the front end was checked next. A signal was evident here at times, then it would disappear. It was clear that we had tuner trouble.

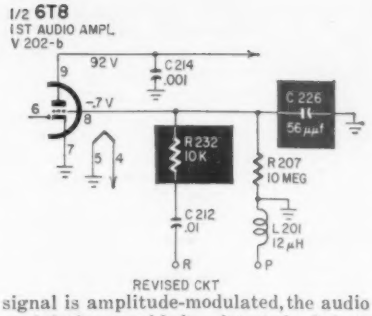
Tapping the tuner sharply caused flashes and rapid changes in picture contrast. So we disassembled the tuner, cleaned it up, and gave it an initial visual inspection. It appeared that an air-core self-supporting coil was caked with green corrosion (see photo). We replaced the coil and realigned the tuner with the aid of an rf sweep generator and scope. This corrected the trouble.—*Robert G. Middleton*

12BY7 VIDEO AMPLIFIER

On sets that use a 12BY7 as the video amplifier and also take sync information through the tube, be careful when checking the tube. Look for a breakdown and shorts. Let the tube cook and draw plate current in the checker (dynamic or mutual conductance) and then go through the short tests as soon as the merit button is released. If any momentary short occurs and then disappears, it means that the tube shorts when it draws current and is a good suspect in cases of sync clipping.—*W. G. Eslick*

RCA 700 SERIES COLOR SETS

In many high-gain audio amplifiers, particularly those with a very high impedance first audio grid circuit, there is a possibility that very strong local rf signals, regardless of frequency, may appear at the grid of the first audio stage. Under certain conditions, this rf signal may drive the tube to the extent that it operates on a nonlinear portion of its characteristic curve, and rectification (detection) can occur. If the rf



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signal is amplitude-modulated, the audio modulation could be detected, fed to succeeding audio stages and be heard from the speaker. This could result in interference to the desired audio signal. If the volume control is located ahead of the first audio grid, it is possible that the control would have no effect on the volume of the interfering signal.

The usual correction for this type of rf interference is to install a simple rf filter at the grid of the first audio amplifier tube. For example, the filter could be installed in one of the 700 series color television receivers in the following manner:

Lift the grid end of the audio coupling capacitor (C212 in CS and CT models; C217 in CD models) from the PW200 printed board. Add a 10,000-ohm ½-watt resistor in series with the capacitor and connect to the grid of the audio amplifier tube. Refer to the partial schematic diagram.

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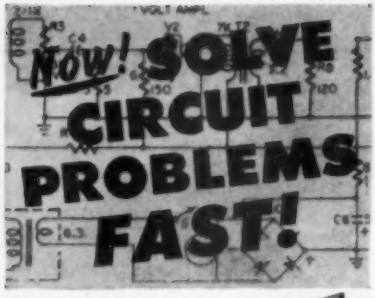

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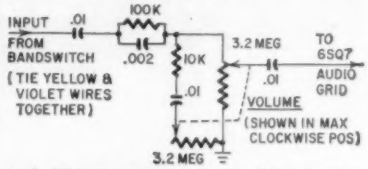
TECHNOTES *(Continued)*

Add a 56-$\mu\mu$f ceramic capacitor from the grid (pin 8) to the cathode (pin 7) of the first audio amplifier tube. Keep all leads as short as possible.

The added resistor and capacitor form an rf filter to prevent strong rf signals from reaching the grid of the first audio amplifier. The capacitor and resistor may be installed on the top or bottom of the printed board. However, if the chassis is out of the cabinet, the capacitor should be connected directly to the tube socket, where it will be shielded. —*RCA Television Service Tips*

CAPEHART 337-RAC-MX

The set, an AM–FM–phono–TV combination, came into the shop with a complaint of fading sound. A thorough check of the audio amplifier section of the tuner chassis turned up an intermittent coupling capacitor. Replacement did not end the fading. I then hesitantly approached the printed-circuit unit connected to the volume control. This is a part of a loudness-control circuit and works in conjunction with a dual potentiometer. The component values within this PC unit were not indicated on my schematic, and a replacement unit was not available. To solve the problem I designed a circuit (see diagram) using ½-watt resistors and ceramic capacitors, which closely approximates the original. It cured the fading.



The circuit I used provides a large boost of high and low frequencies, the crossover being about 1,000 cycles. The amount of boost is lessened as the control is turned clockwise, just as the original control acted. — *Darrell A. Forsberg*

WEAK PICTURE

For weak pictures (washed out or lack of contrast) and sometimes a negative picture, always check the crystal detector (if used). We pass one as OK if it has a forward resistance of 70 to 100 ohms and a back resistance of 1 megohm or better. This is based on a 20,000-ohms-per-volt meter only. On other meters, the test may prove useless. Get some known good diodes and use them to calibrate your meter, but make sure you don't use a vtvm or a vom that applies more than 4.5 volts during resistance checks.—*W. G. Eslick*

HOFFMAN CHASSIS 180

Complaint: No high voltage, low boost voltage.

On this model, pin 3 of the 6W4-GT damper showed only 410 volts instead of the normal 600. Replacing the 6W4 had no effect. When one of the horizontal deflection leads was disconnected, B boost came up to 800 volts. Examination of the deflection coil showed an

optimist?

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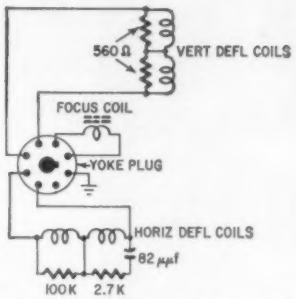
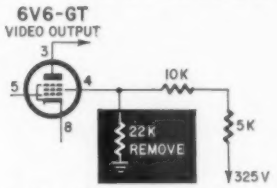


82-$\mu\mu$f capacitor in series with a 2,700-ohm resistor, across half of the vertical deflection coil. The capacitor had shorted and the resistor had started to overheat. The coil's resistance had been checked earlier, but of course the 31-ohm coil seemed OK.—*John B. Ledbetter*

PHILCO 50-T1403

Complaint: Weak video output.

Reason: Check video output tube's screen voltage. If it is 85 volts or less,



remove the 22,000-ohm resistor that shunts the screen to ground. Both plate and screen voltages will go up to normal and video output will be improved.—*Harry C. Keller*

TV HIGH VOLTAGE

I had a TV chassis on the bench and was checking it for a high-voltage leak. The set was making a crackling sound like high-voltage jumping a gap. With my ear close to the yoke, I poked a black fiber trimmer tool against the rubber cover on the anode connector. The tool slipped over the cover and touched the glass between the anode connection and the front clamp on the picture tube. Sparks flew from the tube to the tool and from my ear to the yoke mounting bracket. My immediate reaction was that I saw some small sparks flying along the pix tube from the front mount to the tool, but I am sure it was a streak of lightning that traveled from my ear to the yoke. The incident did no damage, but it was educational.

I discovered a black streak on the side of the picture tube between the anode button and the tube's front mount. Removing it with solvent stopped the arcing.—*Fairbanks Tryon*

EMERSON MODEL 638-B

Complaint: picture would not sync vertically or horizontally—looked ragged at the top right edge.

A high-resistance short between the dual vertical and horizontal hold controls was the cause. Replacing this unit ended the problem.—*Harry C. Keller*

END

50 Years Ago — In Gernsback Publications

HUGO GERNSBACK, *Founder*

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics on file for interested readers.

In September, 1909, *Modern Electrics*

Harnessing Sunlight, by René Homer.
Oscillation Transformers, by H. H. Holden.
(Electrolytic) Interrupters, by A. P. Morgan.
Wireless Key, by Oscar Oehmer.
Wireless Stations About New York: No. 2—Station at the Waldorf-Astoria.
Construction of Loop Antenna Switch, by A. C. Brady.
Semi-Variable Condenser, by T. W. Huntington, Jr.
What Can We Say to Mars—and How?
Revolving Potentiometer for Wireless, by Bernadotte Anderson.
A Novel Non-Heating Spark Gap, by H. Gernsback.
New Idea in Receiving Circuits.
New Aerophone Arrangement.
Loud Speaking 'Phone.
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Included in the "Edu-Kit" course are sixteen Receiver, Transmitter, Code Oscillator, Signal Tracer and Signal Injector circuits. These are not unprofessional "breadboard" experiments, but genuine radio circuits, constructed by means of professional wiring and soldering on metal chassis, plus the new method of radio construction known as "Printed Circuitry." These circuits operate on your regular AC or DC house current.

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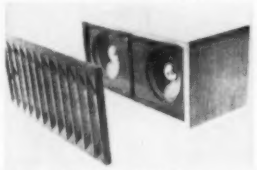
On the Market

CERAMIC PICKUP *model 8TA* stereo cartridge. Greater compliance than earlier model, available with various combinations of microgroove and standard 78 turnover needles, sapphire and diamond, including twin 0.7-mil radius sapphires. Response flat 20–15,000 cycles, rolling off to 20,000; separation

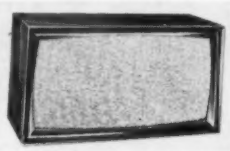
20 db between channels; compliance 3 × 10^{-6} cm/dyne. Output 0.3 volt. Tracking pressure 3–5 grams in transcription arms, 4–6 in changers. — **Sonotone Corp.**, Elmsford, N. Y.

SPEAKER SYSTEMS. *Models CA-80* (shown) and *CA-100* include two 8-inch and two 10-inch drivers, respectively. *CA-100* includes crossover, two 3½-in cone tweeters. Power rating 40 watts program material, im-



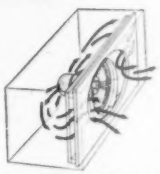
pedance 8 ohms. *CA-80* response 55–13,000 cycles; *CA-100* 45–17,000 cycles. Finished 4 sides, detachable legs. Special woven screen readily removable for cleaning.—**Audax, Inc., Div. of Rek-O-Kut**, 38-19 108 St., Corona 68, N. Y.

TWO-WAY BOOKSHELF SYSTEM, *Duette*. 8-inch woofer, 4-inch tweeter, ducted port en-



closure. Response 36–14,000 cycles, crossover 2,000 cycles, power rating average program material 25 watts. 12½ x 24 x 10½ inches. Also available as a kit, with components only plus enclosure plans.—**Jensen Mfg. Co.**, 6601 S. Laramie Ave., Chicago 38, Ill.

BOOKSHELF ENCLOSURE, *model Eliptoflex*, houses any 12-inch speaker or woofer. Construction similar to reflexed port design, with driver mounted on



board set back short distance from front opening. 14 x 23½ x 13¼ inches.—**Lafayette Radio**, 165-08 Liberty Ave., Jamaica 33, N. Y.

ELECTROSTATIC SYSTEM. Shelf type *model Z-400* includes 11-inch woofer. Fiberglas-filled enclosure. System response 30–30,000 cycles, built-in power

supply and high-pass filter. 15 x 26 x 13½ inches.—**Neshaminy Electronic Corp.**, Neshaminy, Pa.

PA SPEAKERS for corridor use (bi-directional) and for directional use where decor is important. *DU-12 Decor* projector (shown) 400–9,000 cycles, rachet bracket directs at any vertical or horizontal angle. Line trans-

former concealed in base. *Model TW-9* 2-way enclosure takes any 8-inch cone, mounts anywhere.—**Atlas Sound Corp.**, 1449 39 St., Brooklyn 18, N. Y.

AM TUNER KIT *model HFT90*. Choice of 14- or 7-kc bandpass; tuned rf stage; prealigned rf and if coils and transformers; built-in ferrite antenna; 10-kc whistle filter, traveling tuning indicator. Sensitivity 3 μv at 30% modulation for 1-

volt output, 20-db signal-to-noise ratio. Also available factory-wired.—**EICO**, 33-00 Northern Boulevard, Long Island City 1, N. Y.

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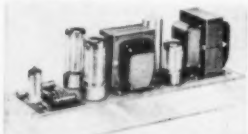
ON THE MARKET *(Continued)*

ECONOMY AMPLIFIER KIT *model SA-3* stereo handles crystal or ceramic pickups, tuners and other medium-level program sources. Bass and treble controls ganged, separate gain controls permit channel balance. Selector

for mono, stereo reverse. Rated 3 watts per channel.—**Heath Co.,** Benton Harbor, Mich.

40-WATT AMPLIFIER KIT *model Mark IV.* EL34 output tubes, printed-circuit board with small parts prewired. Distortion



under 1%, 20–20,000 cycles at 40 watts. Noise over 90 db down.—**Dynaco, Inc.,** 617 N. 41 St., Philadelphia 4, Pa.

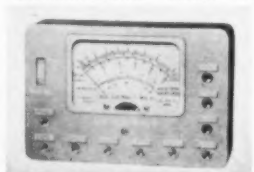
SENSITIVE FM TUNER *model FM-100,* 20-db quieting with 0.8-microvolt input to 300-ohm antenna, 0.4 microvolt to 72-ohm antenna. 2 if's and 2 limiters precede wide-band ratio detector. Germanium diodes in detector. 10 tubes and 4 diodes. Muting control for interstation hash, multiplex separation control, selector, electric-eye tuning

indicator, separate tape recorder and audio outputs on both multiplex adapter and main channels. Provision for plug-in of multiplex adapter.—**Fisher Radio Corp.,** 21-21 44 Drive, Long Island City 1, N. Y.

AM TRANSISTOR PORTABLE KIT *model RA-6* also factory-wired. 6 transistors, 4 x 6-inch speaker, earphone jack, prealigned rf and if transformers, ferrite antenna. Simu-

lated leather carrying case.—**EICO,** 33-00 Northern Blvd., Long Island City 1, N. Y.

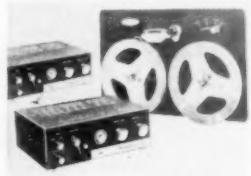
MULTITESTER *model TS-55A* 1,000-ohms-per-volt is compact instrument. 5 ac and dc ranges 10 to 1,000 volts full scale. Dc 1 and 500 milliamps. One ohms range to 100,000. 3¼ x 1⅝ x 5 inches.—**Alco Electronics Mfg Co.,** 3 Wolcott Ave., Lawrence, Mass.



SOUND REINFORCEMENT AMPLIFIERS. *Signet Sound* line includes 10-, 22-, 33- and 70-watt units, all 117-volt-powered.

30–20,000 cycles (*Signet 70* to 20 cycles). 2 microphone and 1 phonograph input (*Signet 10* 1 microphone). *Signet 33* and *70* separate bass and treble controls. Mobile *Signet 8* transistor amplifier 8 watts, response 100–10,000 cycles, 12-volt input; current drain 0.15 amp on standby, 0.5 maximum in use.—**Stromberg-Carlson,** 100 Carlson Rd., Rochester 3, N. Y.

TAPE RECORDER KITS *series TR-1A* includes models for

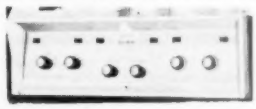


half-track and quarter-track playback/record. 2-speed mechanism with printed-circuit boards in playback/record electronics. Playback output 600 ohms, NARTB equalization. Electric-eye record indicator. Also available stereo conversion kits for changing earlier mono recorder kits to half-track or 4-track stereo record/playback.—**Heath Co.,** Benton Harbor, Mich.

LOW-COST MICROPHONE *model 729.* Ceramic-element car-

diod desk unit. PA, paging and general communications use. Impervious to unusual temperature and humidity conditions. Output —55 db, response 60–8,000 cycles, weight less cable 9 oz.—**Electro-Voice, Inc.,** Buchanan, Mich.

STEREO AMPLIFIER KIT *model SA-40.* Complete dual 20-



watt amplifiers and control preamp on one chassis. Response 30–90,000 cycles ±1 db, harmonic distortion 0.2% at

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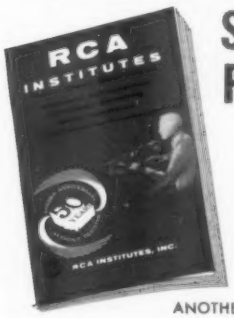

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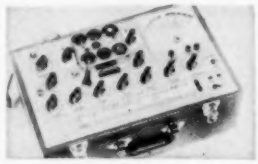
rated output. Stereo balance control, rumble and filter switches, loudness switch, 2-speaker selector, tape-head and microphone inputs. Silicon diode power supply for exceptional regulation. Kit or factory-wired. —**PACO Electronics Co., Inc.**, 70-31 84 St., Glendale 27, N. Y.

STEREO BALANCE CONTROL has 2 L-pads to set level of each stereo speaker. Includes

phasing switch to reverse polarity. *Model SE-8* for 8-ohm speakers, *model SE-16* for 16-ohm units.—**Vidaire Electronics Mfg. Corp.**, 44 Church St., Baldwin, N. Y.

HARMONIC GENERATOR. Low-priced transistor unit injects signals for troubleshooting audio, rf or if stages. Output level control, on–off switch, audio–rf switch. Compact for carrying on service calls.—**Service Instruments Corp.**, 426 S. Westgate Drive, Addison, Ill.

TUBE–TRANSISTOR TESTER *model 6000*. Portable with roll chart grouping most-used



tubes. Tube quality read directly in micromhos (0–3,000, 6,000 and 15,000). 5 neons light to indicate shorts. Line voltage permanently shown. Gas content measured by meter reading directly in micromhos.—**Hickok Electrical Instrument Co.**, 105-31 Dupont Ave., Cleveland, Ohio.

MINIATURE WIREWOUND CONTROLS *series Radiohms*

WW and *WN* rated 5 watts. 1 3/32 x 9/16 inches excluding shaft (about size of conventional 2-watt controls). Values up to 100,000 ohms. Long or short shafts.—**Centralab**, 900 E. Keefe Ave., Milwaukee 1, Wis.

OSCILLOSCOPE KIT. Portable service instrument *model WO-33A* also factory-wired. 3-inch screen scaled to read directly peak-to-peak volts, switch for narrow- or wide-band response. Narrow-band sensitivity 3 mv/inch, 3 db 20–150,000 cycles; wide-band 100 mv/inch, 3 db 5.5 cycles to 5.5 mc. Includes

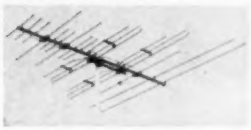
printed-circuit boards, step-by-step instructions and large drawings. Weight 14 lbs.—**RCA Tube Div.**, 415 S. 5 St., Harrison, N. J.

VU METER. Illuminated clear plastic case, 2% accuracy full scale. 3,900-ohm damped 3-inch meter scale, −20 to +3 upper scale. Lower scale 0–100% modulation. Response 20–20,000 cycles. Speed 0.3 second to 99% of steady-state reading on keyed sine wave.—**Argonne Electronics Mfg. Corp.**, 165-11 South Road, Jamaica 33, N. Y.

2-SET ANTENNA COUPLERS can be mounted on mast or wall before attaching set leads. *Model 1600*, standard unit, with resistor network, used within 20 to 25 miles of transmitters. *Model 1602* for fringe

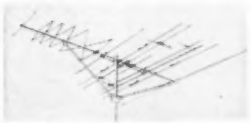
areas. — **Walsco Electronics Mfg. Co.**, 100 W. Green St., Rockford, Ill.

ALL-CHANNEL YAGI *model SCL-4* has 14 elements including 2 driven elements. Antenna folds out; extra boom brace for strength; wraparound, no-crush



mast clamp. — **Winegard Co.**, 3000 Scotten, Burlington, Iowa.

LONG-DISTANCE TV ANTENNA *model PX911* addition to *Power Helix* line. For locations 80–110 miles from stations



over flat land or 60–85 in hilly terrain. 24 elements. Front-to-back voltage ratios up to 28 db. Gain within ¾ db across each channel. — **JFD Electronics Corp.**, 6106 16 Ave., Brooklyn 4, N. Y. END

All specifications on these pages are from manufacturers' data.

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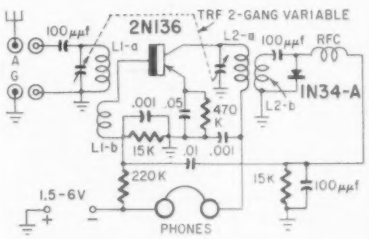

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- ☐ 50—STRIPS ASST. SPAGHETTI best sizes $1
- ☐ 100—ASST. RUBBER GROMMETS best sizes $1
- ☐ 100'—TWIN LEAD-IN WIRE 300(Ω) heavy duty $1
- ☐ 50'—FLAT 4-COND. WIRE many purposes $1
- ☐ 25'—INSULATED SHIELDED WIRE $1
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- ☐ 100'—FINEST NYLON DIAL CORD best size $1
- ☐ 200—SELF TAPPING SCREWS ⌀8 x ½" $1
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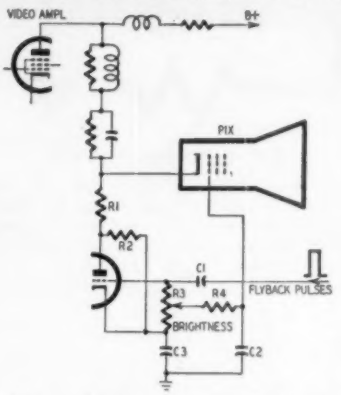
is provided by the triode. In the original receiver video output and black level are provided by a single triode-pentode tube.

During horizontal flyback, a strong



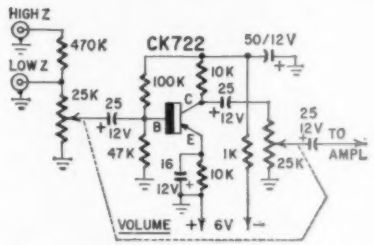
positive pulse is taken from the horizontal output transformer and applied to the triode. There is grid rectification and about 140 volts appears across the brightness potentiometer R3. The time constants, in particular R4–C2, are chosen so that this voltage remains practically constant. Also the value of C1 is such that its charge leaks away slowly enough for the triode to remain cut off between flyback pulses.

The triode then conducts only during flyback, charging cathode capacitor C3 to the maximum voltage appearing during flyback that is precisely black-level voltage.

As the lower end of the brightness control (R3) does not return to ground but to C3, the voltage across C3 is in series with the brightness voltage. In this way the total brightness voltage is effectively clamped to black-level voltage.—*A. V. J. Martin*

IMPROVED PREAMP

In the February, 1958, issue, A. Ladd has an article on a transistor preamp (page 46). The original circuit worked fine, but would overload



easily at both ends. To defeat this problem, I added a dual volume control. One section is at the input and the other at the output. This provides a very versatile system of level selection.—*James C. Soukup* END

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BUSINESS and PEOPLE

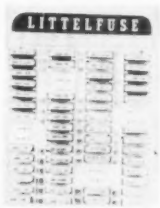
P. R. Mallory & Co., Inc., Distributor Div., Indianapolis, Ind., is holding a "Go Places With Mallory" contest. An all-expenses-paid weekend in Mexico City for two is the grand prize. During the contest, an American Airlines Flight Bag Kit containing an assort-

ment of replacement components is available at a special introductory price. The kit contains an official entry blank for service technicians. Contestants must tell which component they like best.

Astatic Corp., Conneaut, Ohio, is displaying its microphones and accessories

in a new distributor showcase. The permanent fixture features a two-color illuminated plastic header and a free-standing case.

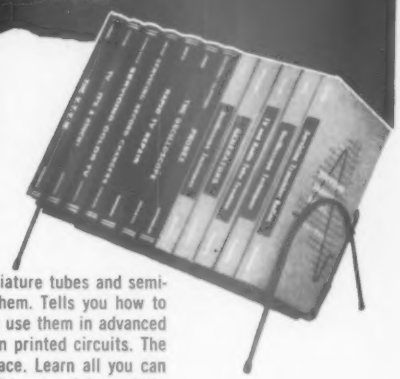
Littelfuse, Inc., Des Plaines, Ill., brought out a new wall-mounting fuse



rack containing 60 different types of its most popular fuses.

Oxford Electric Corp., Chicago, awarded an attractive clock to its Sales Representatives of the Year, Abbett & Hustis, Needham, Mass. Hugo Sundberg, Oxford president, Frank Abbett

Yes...YOU can be an expert on PRINTED CIRCUITS



Printed circuits with their flat, slim look are elbowing out bulky conventional chassis in home and industrial electronic equipment.

But this circuit-shrinking brings in new problems, demands new techniques, requires new knowledge.

Where to get it? — read this new Gernsback book. It takes all the mystery out of printed circuits. Shows you how they developed, how they're made, how to make your own. Describes the special resistors, capacitors, subminiature tubes and semiconductors and other components used with them. Tells you how to work with them, repair them, and finally how to use them in advanced applications. It's practically an encyclopedia on printed circuits. The future of printed circuits is as limitless as space. Learn all you can about them now. It's easy to be an expert. This new deluxe cloth-bound G/L book shows you how. Get it today and see.

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6AG7	.99	6SJ7	.69	25Z6	.99	811	3.00
6AH6	.90	6SK7	.72	25W4	.77	812	3.00
6AK5	.69	6SL7	.80	25Z5	.63	813	9.00
6AL5	2/$1	6SN7	2/$1	26A6	.75	814	3.45
6AQ5	.63	6SQ7	.74	EL34	3.49	815	2.75
6AS7	3.00	6SR7	.79	EL37	2.49	826	.59
6AT6	.49	6T8	.98	35L6	.69	5998	8.00

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6BA7	1.00	6X5	.49	50C5	.69	5881	2.70
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and Walter Hustis (left to right) are shown as Tom Brown, vice-president and general manager of Oxford Components, Inc., makes the award.

Fairchild Recording Equipment Corp., Long Island City, N. Y., is offering consumers a cartridge installation kit with its new SM-1 stereo and monophonic

cartridges. The kit includes a gram gauge, small screwdriver and instructions in English, French and Spanish, in addition to the usual hardware.

Channel Master Corp., Ellenville, N. Y., entered the receiving-tube field with a line of tubes made by the Japanese firm, Nippon Electric Co. Tubes are sold under the Channel Master name. The company has been merchandising a complete line of TV picture tubes on the West Coast and expects to expand nationally at a later date.

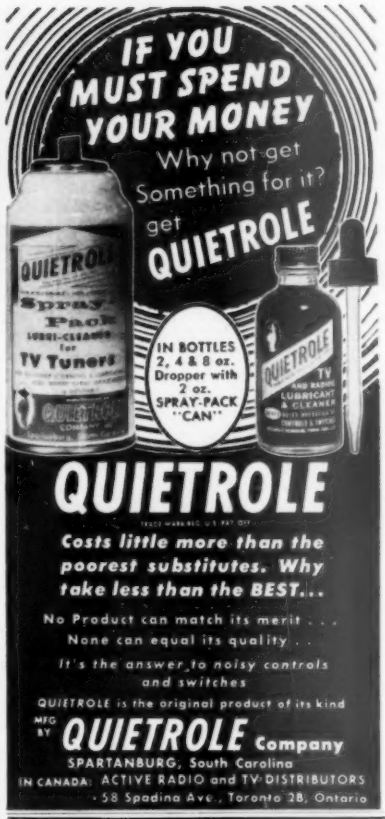
EIA Production & Sales Reports, first five months:

	1959	1958
TV Production	2,211,712	1,790,840
Radio Production	5,677,421	3,876,737
FM Radio Production (May only)	48,841	Not available
Retail TV Sales	1,919,162	1,927,290
Retail Radio Sales*	2,480,686	2,084,937

**Excluding automobile sets.*

John E. Johnson was elected vice president and marketing manager, Electronic Data Processing Div. of RCA. He joined the company last year from Minneapolis-Honeywell Regulator Co., where he was marketing vice president of the Datamatic Div.

Joseph E. Kelley was promoted to manager, merchandising, distributor tor products, RCA Electron Tube Div., Harrison, N. J. He was manager, merchandising, indus-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trial tubes and semiconductors for the Distributor Products Organization.

Walter A. Clements (left) was elected vice president in charge of distributor sales and advertising for Littelfuse,

Inc., Des Plaines, Ill. **Herbert A. Cornelius** was named vice president in charge of sales to industrial manufacturers.

Marvin Rubin joined Allied Radio Corp. in Chicago as staff assistant to **Alex Brodsky**, vice president and general marketing manager. He comes to the company from Bell & Howell, where he was manager of specialty sales.

Mel Buehring was named director of sales for Simpson Electric Co., Chicago. He had been sales manager. In other personnel assignments, **William Johansen**, assistant sales manager, became sales manager of the Instrument Div.; **Lowell De Wolf**, sales manager of the Automotive Div.; and **Harry Jones**, controller. **William Coon**, director of Engineering, is now technical assistant to the president; **Peter Do Paolo**, chief engineer, is director of engineering; **Irvin Rebeschini**, chief engineer of Electronic Test Equipment, and **Ed Evensen**, chief engineer of automotive test equipment.

Paul P. Wickman joined Radio Shack Corp., Boston, as vice president for industrial and government sales. He comes from the Electronic Components Div., of General Electric.

William A. Hayes, eastern regional sales manager for the Westinghouse Electronic Tube Div., Elmira, N. Y., was presented with a pin commemorating his 25th anniversary with the company. **J. J. Doyle**, (left) renewal sales manager, is presenting the pin as **Lou Martin**, general marketing manager, looks on. END

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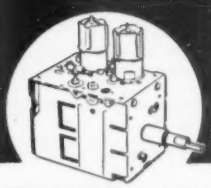

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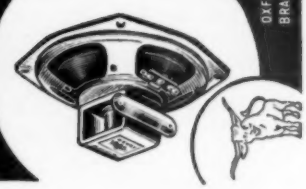

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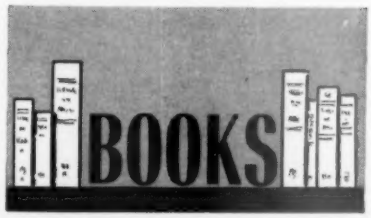

TUBE & SEMICONDUCTOR SELECTION GUIDE, 1958–1959, compiled by Th. J. Kroes. Philips Technical Library, N. V. Philips' Gloeilampenfabrieken, Eindhoven, Netherlands. 6 x 9¼ in. 160 pp. $1.50.

A comprehensive text that lists all vacuum tubes and semiconductors that can be replaced with Philips units. The listing gives the type number and the suitable Philips replacement. The introduction is presented in six languages, and translations of technical terms from French, German and Spanish into English are also given.—*LS*

BUILDING THE AMATEUR RADIO STATION, by Julius Berens. John F. Rider Publisher, Inc., 116 W. 14 St., New York 11, N. Y. 5½ x 8½ in. 128 pp. $2.95.

A valuable book for anyone planning to get on the air as a ham. Written as a practical step-by-step guide, it can also serve as a good general background piece for the new amateur.

It starts with the simplest physical matters, including how to solder, how to read diagrams and how to drill chassis. Hardware and components are pictured and described briefly. The layout and construction, testing and actual getting-on-the-air of a 15-watt transmitter (and suitable receiver) are described. Next a 50-watter, for the ham who goes on beyond Novice to get his General license, is detailed. Even the antennas are discussed in detail.

Next is a section cataloging and discussing currently available receivers and transmitters. And finally there's a section on actually operating the station.—*CG*

ELECTRONIC CIRCUIT THEORY, by Henry J. Zimmerman & Samuel J. Mason. John Wiley & Sons Inc., 440 Fourth Ave., New York 16, N.Y. 6 x 9¼ in., 564 pp. $10.75.

Primarily a college text, the book was written for the electrical engineering course at The Massachusetts Institute of Technology. However, the engineer will find it a valuable reference volume.

Eleven major sections, four appendices and an index are squeezed between the covers. Titles of some of these sections are: electrical conduction and diodes, transistor models and circuits, wave shaping and amplification, and oscillations in RCL circuits.—*LS*

AUDIO CYCLOPEDIA, by Howard M. Tremaine. Howard W. Sams & Co., Inc., Indianapolis, Ind. 6 x 9 in. 1,269 pp. $19.95.

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(*Continued on page* 140)

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Many answers are pages long, and include necessary charts, formulas, design procedure and much detailed data. It's a one-volume library.—*IQ*

INTRODUCTION TO THE DESIGN OF SERVOMECHANISMS, by John L. Bower and Peter M. Schultheiss. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 6 x 9 in. 510 pp. $13.

This text offers a complete and basic understanding of servo design to students at senior and gradual level. It discusses feedback systems, stability and nonlinearity. The Laplace transform, an essential mathematical tool, is discussed early in the book and is widely used thereafter.—*IQ*

FUNDAMENTALS OF HIGH FIDELITY, by Herman Burstein. John F. Rider Publisher, Inc. 116 W. 14 St., New York 11, N. Y. 5½ x 8½ in. 136 pp. $2.95.

Unlike many primers on the subject, this well-organized introduction devotes minimum space to components and concentrates on the subject itself—the why, as opposed to the equipment. In simple, direct English, the author sets forth the meaning of key terms: decibel, response, distortion and noise. Then, using these, he examines current practice in recording and playback.

By the end of the book, the novice will be equipped to search intelligently; any but the most advanced will find his information more logically arranged. The book is for the nontechnician primarily (though one must be able to read simple graphs), but it will help anyone not already very expert in the field.—*CG*

ELECTRONIC CIRCUITS, by E. J. Angelo, Jr. McGraw-Hill Book Co. Inc., 330 W. 42 St., New York 36, N.Y. 6 x 9¼ in. 450 pp. $9.

A text for the electrical engineering student written with the aim of "unifying the study of electronic circuits by developing and exploiting basic concepts common to large groups of tube and transistor circuits." Among the topics covered are graphical analysis of basic amplifier circuits, pentode equivalent circuits, the Miller effect, tuned amplifiers, properties of feedback amplifiers.—*LS*

INDUSTRIAL TELEVISION, by H. A. McGhee. D. Van Nostrand Co., Inc., Princeton, N. J. 5 x 7 in. 119 pp. $4.

This book explains details of British closed-circuit television cameras and pickup tubes, for technicians and engineers. Liberal use is made of block and schematic diagrams. Circuit details of typical cameras are investigated in one chapter entitled, "Design of Equipment." A number of interesting applications are described, with particular emphasis on the mechanical and other nonelectronic angles. Among these are underwater television, television microscopy, television telescopes and stereoscopic television.

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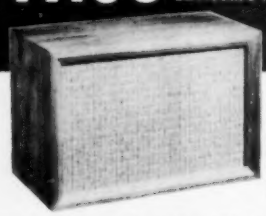

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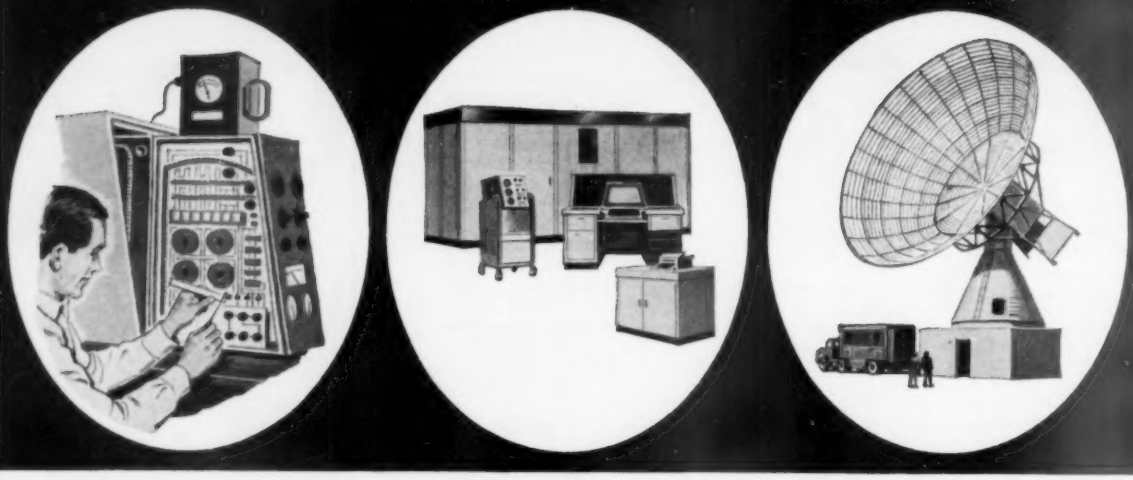

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